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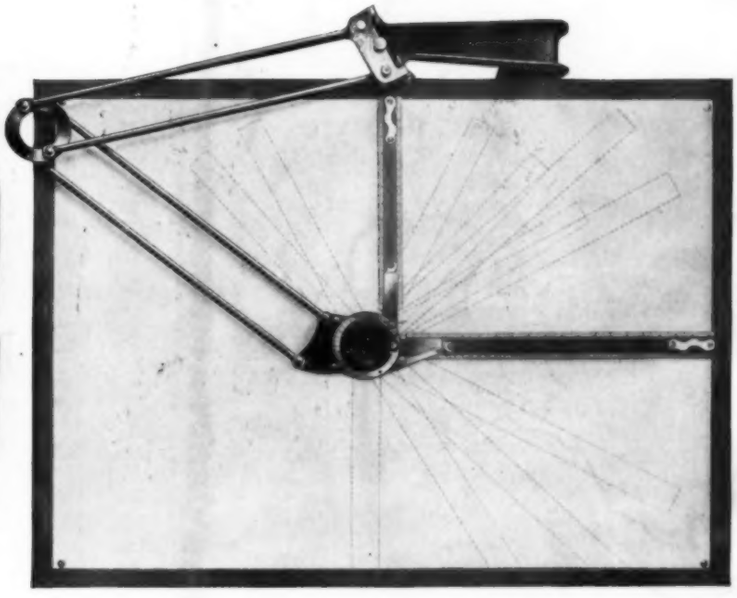

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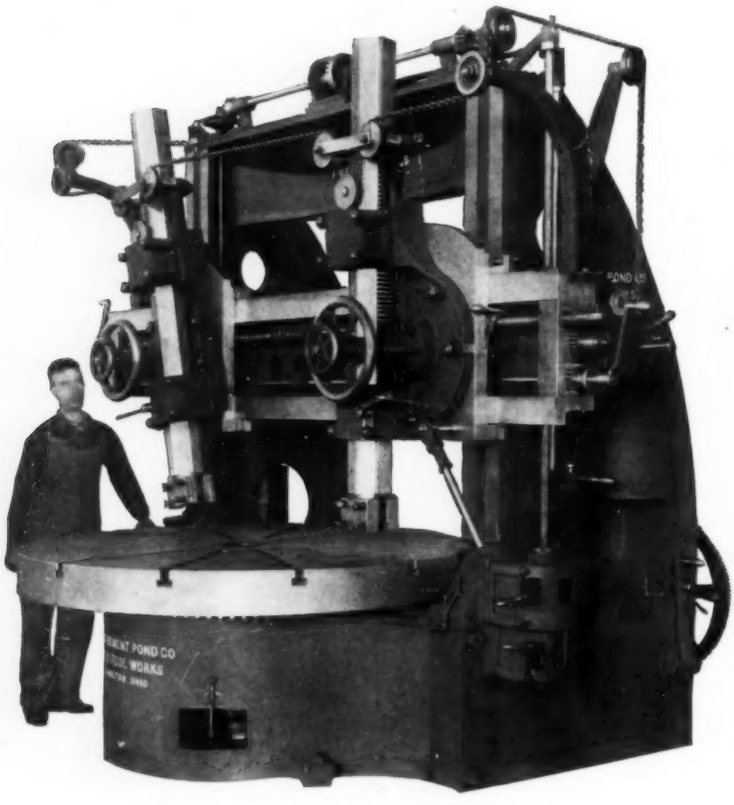

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(*See pages* 43, 44, 45, 46 *and* 47)

Broaches and Broaching Processes

By C. B. Auel *

Adoption of broaching operations upon a large scale by a leading manufacturing concern, with interesting results and gradual extension of the process.

Bearings of cast iron, bronze and babbitt for railway and other motors are finished by broaching, and various other parts having round, rectangular and irregular openings are machined in similar fashion.

Details of work, broaching tools, finishing allowances and other items of importance.

*Assistant manager of works, Westinghouse Electric and Manufacturing Company.

Some 20 years ago, the Westinghouse Electric and Manufacturing Company endeavored to secure for its babbitted armature bearings, which were then largely of the one-piece or solid type, longer life by rolling the babbitt, thereby compressing the material and thus making it more compact, harder and better able to resist wear. The bearings after rolling, were reamed to give a smoother surface. While improvement resulted, it was not especially marked, and further, the process proved altogether too laborious and expensive for this class of work. Accordingly attempt was made to reach the same end by drifting or forcing a plug through a bearing. It was found, however, that this was not feasible, as a plug but 0.005 inch larger than the bore could not be driven through without either bursting the bearing or else stalling a 60-ton hydraulic press that was being used.

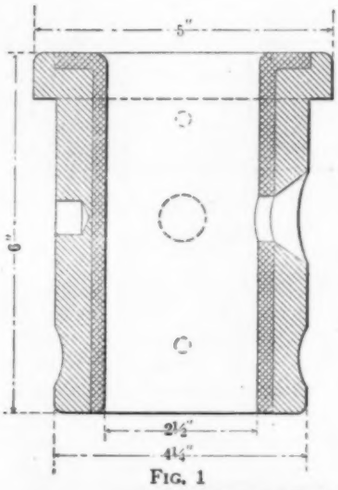
Adopting the Broach

The plug was next turned into a broach. The front end was made cylindrical and of such size and length as to fit the bearing snugly and thus to serve as a guide; the body or broach proper was tapered outward slightly for about one-third the total length of the plug, the remainder being again made cylindrical but to finished size, and for a distance sufficient to enable the cutting portion to be pushed entirely through the bearing. Between 10 and 15 tons pressure was required to force the broach through the hole, and a beautifully finished surface was obtained, but the original idea of making the metal more compact had, in some degree, been sacrificed.

Such in very briefest outline were the early steps which led up to the introduction of the process of broaching at the Pittsburg works of the Westinghouse Electric and Manufacturing Company, though it is not intended to convey the idea in any way by the preceding statement that this company was the pioneer in work of this kind.

Extension of the Process

The developed process was extended from time to time until there were included within its scope not only babbitted bearings, both of the one-piece (solid) and two-piece (split) types, but certain one-piece unbabbitted bronze bearings of the smaller sizes, as well as cast brass carbon holders, controller handles and controller drum rings, cast-iron controller drum rings and small motor spiders, etc.



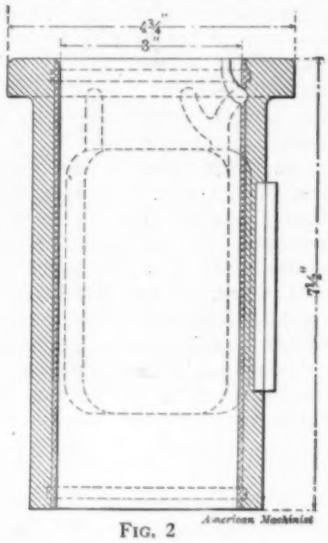


Fig. 1 Babbitted Bearings Finished by Broaching

Fig. 2

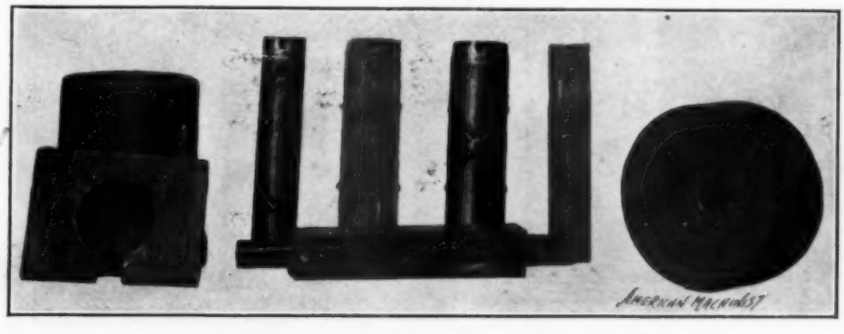


Fig. 3. Collapsible Babbitting Mandrel

Fig. 4. Collapsible Babbitting Mandrel Assembled in the Bearing

It was at one time tried out experimentally as a possible substitute for filing in connection with the teeth of armaure cores; but, while mechanically, the results were apparently satisfactory, electrically they were not, since the core losses were increased. The wonderful strides made in the last few years in the manufacture of armature punchings, due to improved methods not only in the making of dies, but in the composition and the heat treatment of the sheet metal as well, have, however, almost entirely eliminated the need of the finishing operation of any kind on armature cores.

Practically all babbitted railway, mine, crane and industrial-motor bearings up to

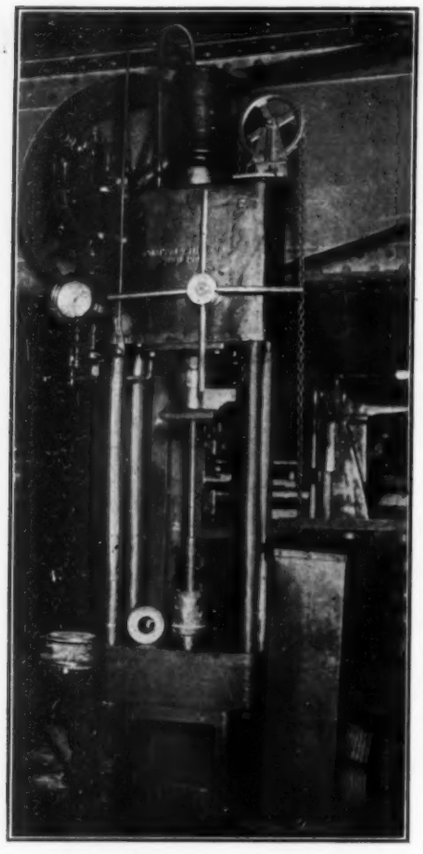


FIG. 5. A BROACHING OPERATION

4½ inches and even 5 inches diameter, when made either to standard bores, or if special, in sufficiently large quantities, now have a broaching operation performed upon them. Over these diameters, the cost of the broach becomes too expensive for the quantities ordinarily involved and such bearings are generally machined in the usual way. The broaching operation may be either a "rough" or a "finish" one, or it may include both. The operation of rough broaching simply roughs out the bore, a subsequent operation either by a further broaching or by boring being necessary to complete this part of the bearing; this second operation is termed "finish" boring.

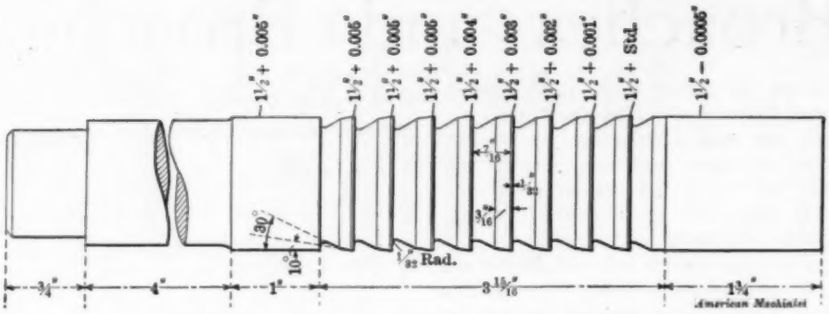


FIG. 6. DETAIL OF STANDARD BROACH FOR BEARING

SOME BABBITTED BEARINGS

Fig. 1 shows a one-piece babbitted cast-iron armature bearing (2½x6 inches) for a light street-car motor, while Fig. 2 illustrates a similar but larger babbitted-bronze bearing (3x7½ inches) for a heavier railway motor, both of which are regularly broached. In the babbitting of one-piece bearings, if the oil grooves are to be cut in afterward instead of being cast in with the babbitt, the babbitting mandrel may consist of a plain round bar, slightly tapered, to permit of its being withdrawn from the mold after the babbitt has been poured. In bearings, however, where the oil grooves are cast in, collapsible mandrels of various types are generally used, and one of these corresponding to the bearing in Fig. 1, is shown in Fig. 3.

As will be seen, it consists of seven parts, namely, a base, four side pieces, a central core and a collar, the core and the side pieces having tapered inner surfaces, so that after a bearing has been babbitted, the core can readily be withdrawn from the mandrel, thus enabling the side pieces to collapse and in turn be taken out. The mandrels are made from 0.004 inch to 0.020 inch smaller in diameter than the finished bearings, leaving this amount of babbitt plus the clearance allowance to be removed by the broach.

OPERATIONS ON ONE-PIECE BEARINGS

In babbitting one-piece cast- or malleable-iron bearings, the rough casting is thoroughly cleaned and the anchor holes or grooves freed from sand, after which the flange is faced off, turned and counterbored, the first two machining operations being necessary to enable the bearing to be placed flat as well as to be located centrally upon the mandrel, the

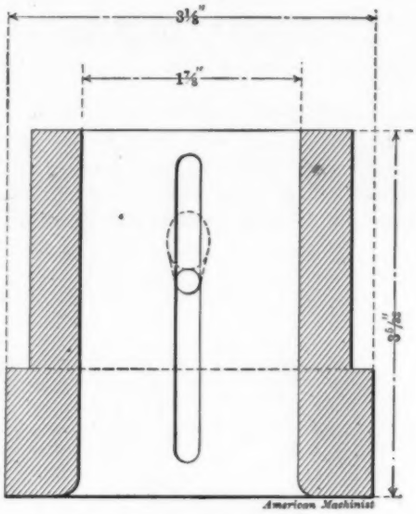


FIG. 8. SECTION THROUGH A SMALL BEARING

last to give the right wearing depth to the babbitted shoulder. If the inside of the casting is lumpy or uneven, it should in addition, be rough bored, so as to permit of a uniform thickness of babbitt lining, with consequent maximum wear in service. The bearing is then slipped

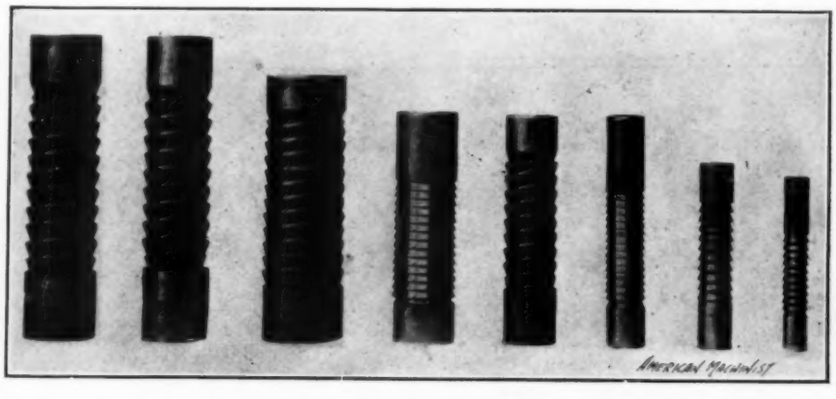


FIG. 7. GROUP OF STANDARD BROACHES FOR BEARINGS

over the assembled mandrel, as shown in Fig. 4, and babbitted, the cored holes, if any, first being fitted with metal or wood plugs to retain the babbitt temporarily while pouring and subsequently while hardening within the shell.

After babbitting, the mandrel and plugs are removed, the fins and any surplus babbitt penetrating the cored holes are burned away with a hot soldering iron, the oil grooves are finished off and the bearing broached, as shown in Fig. 5. A pressure of 5 to 10 tons is required, depending upon the diameter and the length of the bearing, as well as upon the hardness of the metal and the amount removed. The actual time of broaching is very small, in general varying from one to two minutes. The bearing is next placed upon an arbor, turned and faced in a lathe, after which it is either profiled

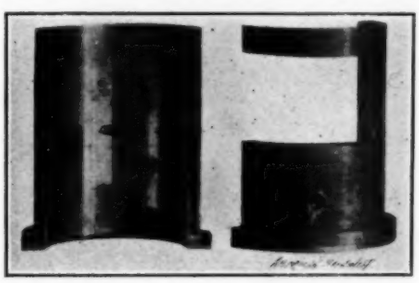


FIG. 9. A DIFFICULT BEARING TO BROACH

on the outside for a key-way or similarly drilled for a dowel pin when it is then completed. It is sometimes necessary, especially when the oil grooves are cut in the lining after babbitting, to run the broach through the bearing a second time in order to remove any slight roughness from the edges of the oil grooves.

BROACH DETAILS

A reproduction of a standard broach used for bearings, whether babbitted or of bronze, is detailed in Fig. 6, and in Fig. 7 is illustrated a group of such

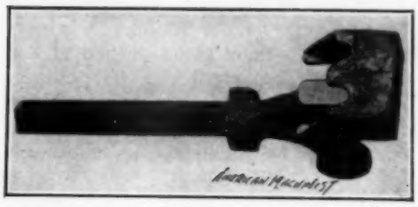


FIG. 11. A CARBON HOLDER WITH BROACHED SLOT

broaches. It is to be noted in the detailed broach that while it is for a bearing to accommodate a shaft of 1½-inch diameter, the maximum diameter is 0.005 inch in excess of this dimension, the difference allowing for the running fit required and for any slight "come back" in the babbitt after broaching. Experience seems to indicate that there is a tendency for the babbitt to expand very gradually after broaching, so that a bearing which has been allowed to stand for several months will sometimes show a slightly reduced diameter and this tendency must be allowed for in the broach.

It is further to be noticed that among the broaches shown, are some in which the cutting edge is a continuous spiral, while in others the cutting is done by a series of circular edges entirely independent of one another. As far as the actual cutting is concerned, there is no appreciable difference between the two types, but in the matter of keeping the broach free from cuttings, the spiral design is much to be preferred.

IMPORTANT CONSIDERATIONS

The method of procedure in the machining of one-piece bronze bearings, differs in several respects from that of one-piece cast- or malleable-iron bearings, depending upon the design which may be patterned in any one of three ways: (1) They may be bronze only, without any babbitt lining; (2) they may have a thin lining of babbitt; or (3) they may be simply "wiped" with babbitt after being otherwise finished, the object of this "wiping" being to insure cool running upon first going into service and until the shaft journal and the bearings have had time to accommodate themselves to each other. When motors are equipped with bronze bearings, it is generally on account of lack of space which prevents the use of the thicker cast- or malleable-iron shells. The bronze bearing being of greater strength, not only permits of

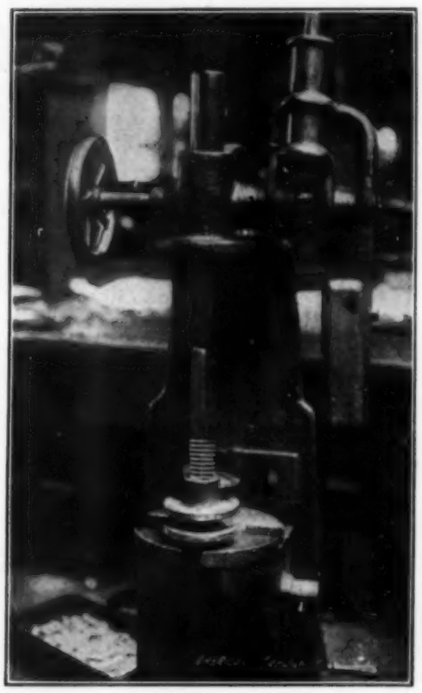


FIG. 12. BROACHING A BRUSH HOLDER

a much thinner section for the same size of bearing, but there is, with babbitt-lined bronze bearings, an additional advantage in that a motor thus equipped, can continue to operate satisfactorily, should the babbitt be worn entirely through from any cause. With babbitt-lined, cast- or malleable-iron bearings, this would hardly be possible.

MACHINING BRONZE BEARINGS

In machining, the bearing is first rough bored (even when it is to be lined with babbitt), then rough turned. If it is to be unlined or simply "wiped" with babbitt, it is next either finish broached or finish bored, usually the latter, unless the bearing is a small one, as shown in Fig. 8. It is then finish turned, grooved for oil ducts, drilled for a dowel or profiled for a key-way and finally "wiped" with babbitt, when this last operation is specified. If the bearing is to be babbitt lined, it is, after being rough bored and rough turned, placed upon the babbitting mandrel and babbitted when the operations then follow one another, as in the case of an unlined bearing.

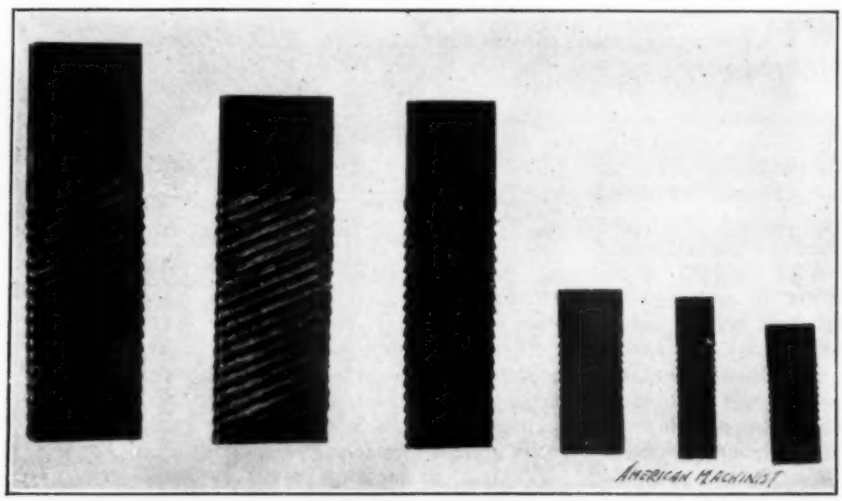


FIG. 10. SOME RECTANGULAR BROACHES

Were the operations of rough and finish bore or finish broach to be performed in sequence, and the bearing thus be finished wholly on the inside before being machined at all on the outside, it would, owing to the thinness of the shell and the consequent spring in the metal, very likely result in making the bore run out of true with the circumference. Of course,

FIG. 13. A 3-SLOT CARBON HOLDER

where the bronze shell is of sufficient thickness to preclude the possibility of its being sprung out of shape, the preceding remarks do not apply, and the successive steps in the machining may differ accordingly from the foregoing.

UNSATISFACTORY FORMS FOR BROACHING

In certain types of bearings, as shown in Fig. 9, whether of cast or malleable iron or of bronze, the design is such

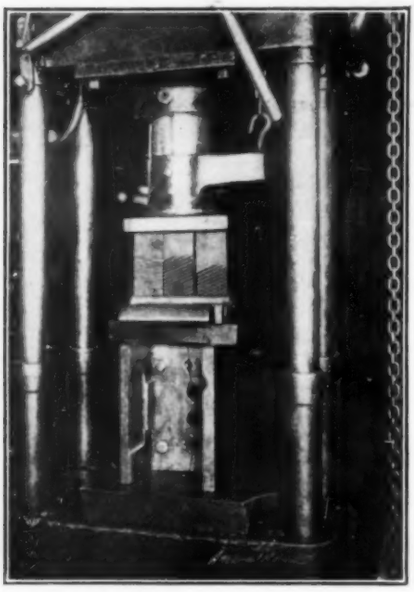


FIG. 14. BROACHING THREE SLOTS SIMULTANEOUSLY

that broaching alone is insufficient to give a perfect hole, and such bearings, while they may be rough broached, should in general be finish bored, if the very best results are to be obtained. This is on account of the great amount of metal omitted on one side of the bearing, due to the large oil hole, which omission causes the broach, when being driven through, to do but little or no cutting on the side opposite the oil hole, this portion of the bearing being pushed to one side by the broach during its passage. There is, however, a way in which this tendency may frequently be overcome and that is by filling the oil hole with babbitt and inclosing the bearing in a suitable pot while broaching, the babbitt in the oil hole afterward being burned out. The broach is thus uniformly supported all around, and is enabled to cut a clean hole and one which is concentric with the circumference of the bearing.

EXPERIENCE WITH TWO-PIECE BEARINGS

Considerable difficulty was encountered when the broaching of two-piece babbitted bearings was first undertaken and various experiments were made without attaining any pronounced success. The half bearings were milled or profiled along the edges, then fitted together, faced, counterbored and babbitted. The complete bearing was next set within a forged ring around the circumference of

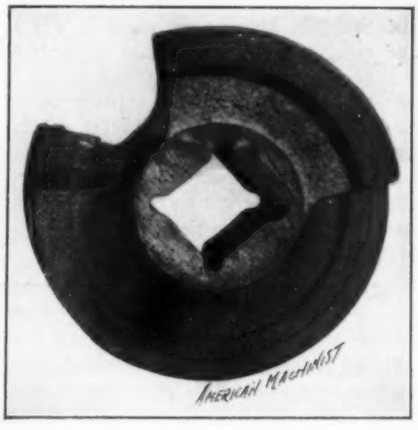


FIG. 15. CONTROLLER DRUM RING WITH BROACHED HOLE

which and projecting inwardly, were placed adjustable screws which could be set tightly against the bearing, thus securing it firmly in a central position, the idea being to have one such ring take in a number of sizes of bearings. Upon driving home the broach, the halves of the bearing separated slightly, due to an almost imperceptible springiness in the several parts, sufficient, however, to prevent any really satisfactory broaching from being done. Modifications of this method showed that seemingly the best if not the only way to broach two-piece bearings, was to surround them with a very heavy, snugly fitting ring made practically for but one kind of bearing and of such size and strength as to preclude the possibility of distortion, and this is much like the method at present followed.

The two half bearings, after being machined and babbitted, as outlined, are placed in a ring or pot and rough broached, after which they are removed, then inclosed in suitable clamps, mounted on an arbor and rough and finish turned in a lathe. They are next placed in a second ring or pot and finish broached, this second ring differing from the first in that the bearing fits it snugly; whereas, the first ring, on account of the bearing be-

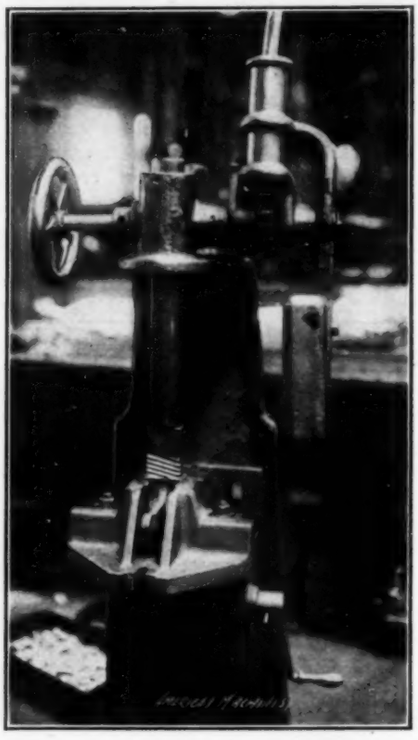


FIG. 16. BROACHING CONTROLLER DRUM RINGS

ing in the rough and not yet turned, is provided with short inwardly projecting heavy, adjustable set screws which hold the bearing tightly in position.

MAKING CARBON HOLDERS

In the making of cast-brass carbon-holders, the practice of broaching, though

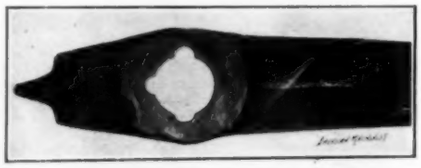


FIG. 17. CONTROLLER HANDLE DRILLED BEFORE BROACHING

very common a few years ago with this company, has in large measure been superseded by slotting, mainly for two reasons: (1) The castings are now made much thinner than formerly and if broaching were resorted to, the loss by breakage would be very large; (2) in carbon-holders containing more than a single cored slot, it is always more or

less difficult to broach the slots in exact alinement with each other, owing to the tendency of the broach to follow the hole.

The use of slotters running at comparatively high speeds, together with the development of special cutting tools and jigs, with the consequent ability to employ a relatively cheap grade of labor, has thrown the balance once again in favor of the slotter and against the broach. Applied to carbon-holders, however, the process of broaching is practically the same as with bearings except for the shape of the broach which is rectangular instead of cylindrical and relatively narrow compared to its width. Several broaches of this kind are illustrated in Fig. 10, while Figs. 11 and 12 illustrate a type of unit carbon-holder which lends itself very nicely to the process of broaching.

In Figs. 13 and 14 is shown a three-slot carbon-holder which though much more complicated in design, can still be readily broached. The cored holes of the casting, however, require to be extremely accurate or else filing must be resorted to, in order that the broaches which are all driven through together, may first be properly alined by means of a straight edge. As with bearings, the broaching is usually among the first of the machining operations to be performed, the sides of the broached slot being taken as the base or starting point from which the other dimensioned parts of the carbon-holder are jigged or laid off. In this way the tendency of the broach, as previously pointed out, to follow the general direction of the cored hole, has no deleterious influence on the succeeding machining operations, whereas were any other machining operation to precede that of broaching, it might become almost, if not quite, impossible to secure a properly alined slot by means of the broach.

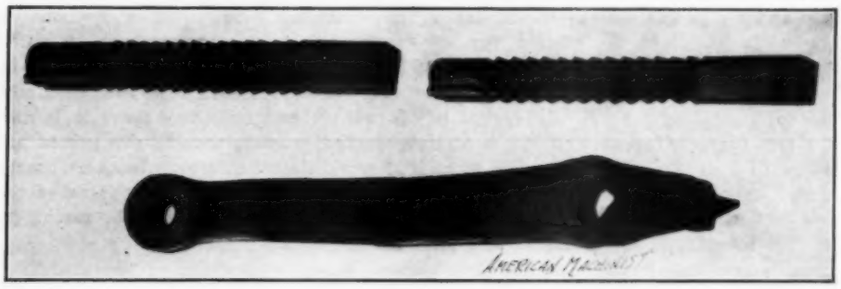


FIG. 18. BROACHES FOR CONTROLLER HANDLES

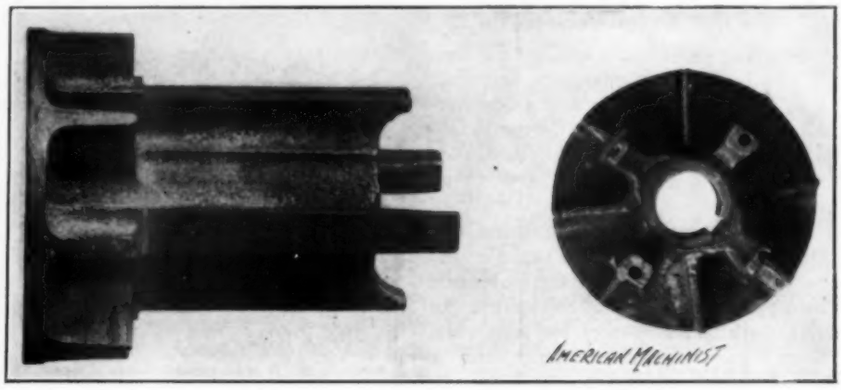


FIG. 19. CAST-IRON SPIDER WITH BROACHED KEYWAY

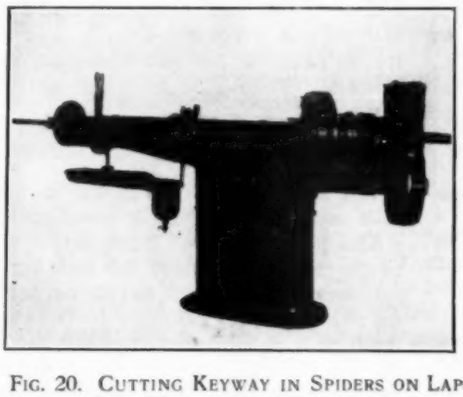


FIG. 20. CUTTING KEYWAY IN SPIDERS ON LAPOINTE BROACHING MACHINE FIG. 21.

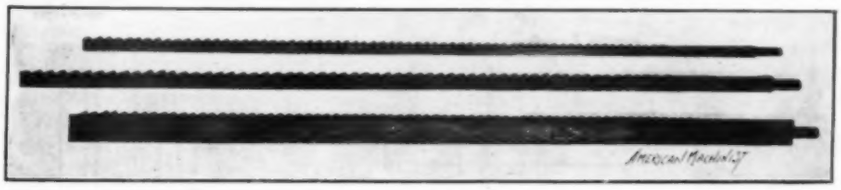


FIG. 22. LONG BROACHES FOR KEYWAYS

BROACHING CONTROLLER PARTS

Controller drum rings, such as that shown in Figs. 15 and 16, are likewise easily broached, the operation being done usually on a hand instead of on a power press. It will be observed that clearance has been provided in the corners of the cored hole while in the case of the carbon-holder just given, this could not be done on account of the requirements of the design.

In the examples thus far cited, the broaching has for obvious reasons, been the first machining operation and though this is the common practice, it is not universally true. When used in the manufacture of certain styles of controller handles, one of which is shown in Fig. 17, it is sometimes preceded by a drilling operation, a small hole being first drilled where each of three of the corners of the hole in the handle is to be, after which a larger drill is used and as much of the proposed hole cleared as possible. Fig. 18 shows the style of broach used for this class of work and a glance at it will at once indicate the purpose of drilling the small corner holes.

CUTTING KEYWAYS

A further very good example of this kind is illustrated in Fig. 19 which is that of a small cast-iron spider for an industrial motor. In this case, after the boring and turning have been done, the spider is placed upon a cylindrical jig attached to a power broachng machine as shown in Figs. 20 and 21. Upon operating the machine by means of the screw, the broach is drawn through the bore of the spider, and the key-way thus cut. Fig. 22 shows several of the broaches used for this class of work. It is of interest to note that the operation in this case is a "pulling" one performed by a machine specially constructed for the purpose, while in the previous instances it is a "driving" one done either on an ordinary power or on a hand press.

In addition to the various examples given of broaching, there are, of course, many others, a few of which may simply be cited here, as for instance, the cutting of multiple key-ways in a single hole or bore, the making of small internal tooth gears and ratchets, the spiral grooving of bores, the cutting of taper, dovetail and other irregular and oddly-shaped holes, etc.

Limitations of the Broach

Both from what has been said in the preceding discussion as well as from what may be inferred, it will be seen that the broach, though distinctly useful along certain lines, as a shop tool, is decidedly limited in its field of application. It requires to be designed with the utmost care in the first place, if best results are to be obtained, and equal care is necessary in its construction. The first cost must in consequence of these two items, be considerable and a glance at any of the broaches shown is sufficient to indicate further that the cost of maintenance is likely to be comparatively high, and the length of life correspondingly short. In regard to this last feature, however, if the broach is one of a number of progressive sizes, it may upon becoming worn below workable dimensions for the size originally intended, be machined ofttimes to suit the next smaller size and in this manner a considerable economy effected.

Where attempt is made to restrict the "free" movement of the broach by guiding it in any rigid way, it will also be found that the loss by breakage, either of the teeth in the larger broaches, or of the broaches themselves in the smaller sizes, will be quite appreciable. Finally, even though all other requirements be met, the casting or piece for which the broach is designed, may prove to be unexpectedly weak, making the percentage of work discarded from cracks or breaks as a result of broaching, altogether out of proportion to the possible saving by the use of the broach.

Threading Sheet Metal Screws

By H. W. Sirius

Single and double end—or open and closed—machines employed for this purpose, with capacities ranging from small thermometer cases to large tubes and caps.

No apparent standard relationship of pitch to diameter; ratios commonly used and giving satisfaction in practice.

Proportions of thread parts, and some points in setting up for threading.

Threading sheet-metal screws is a simple and inexpensive operation, economical of material and labor and a commercially accurate process. After the essentials have been grasped, the design of threading rolls or "chucks" becomes an every-day job.

Standard threading and trimming machines are much the same, simple and easily set up for different sizes of work. Open-end machines are convenient for small work and necessary for long work. "Open" and "closed" machines refer to the position of the spindle bearings. If the bearings of both spindles be to one side of the rolls, the machine is said to be "open" or single-ended, as shown in Fig. 1. The double-end or "closed" machine arrangement is indicated by Fig. 2.

Capacities vary from ¼x5-inch clinical thermometer cases to 2x10-inch dust and waterproof document tubes. The capacity of closed-end machines is usually limited to 8 inches diameter of thread, though generally allowing for a greater swing of work, say 12 to 14 inches, the thread not to be longer than 2 inches. As to the gage of the stock (0.020 inch is usually the limit for thickness, though it may go down to 0.006 inch).

Pitches and Diameter

There does not seem to be any standard relation of pitch to diameter, but for general purposes the following ratios are much used and have given satisfaction over several years' use: Under ¼ inch diameter, 10 threads per inch; ¼ inch diameter, eight per inch; 1 inch diameter, seven per inch; 3 inches diameter, six per inch; 6 inches diameter, five per inch; 8 inches diameter, four per inch. Ten threads per inch is generally used for shallow work of any diameter, say a 3-inch cap ⅜ inch deep, where the standard pitches would be too coarse and probably warp the work too much. Lamp burners, fruit jars, and other fittings have standards and limits that must be adhered to. Some difference in diameters must be allowed between the neck and the cap for the right fit of the thread, depending obviously on the thickness of stock and pitch. For the standards given above and the usual gages of tinplate or brass, the following will apply: One inch diameter, 1/32 allowance; 2½ inches diameter, 3/64 inch; 4 inches diameter, 1/16 inch; 8 inches diameter, 3/32 inch; for 10 pitch, shallow work, medium diameters 1/64 to 1/32 inch will usually suffice.

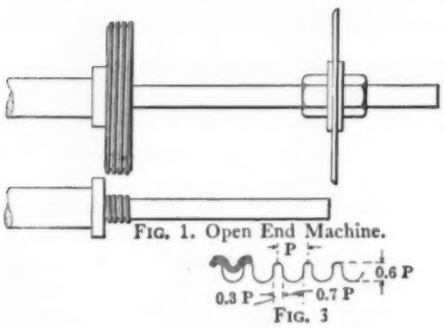


Fig. 1. Open End Machine.

Fig. 3

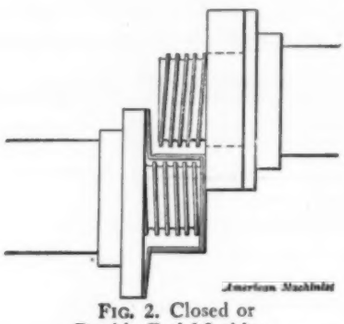


Fig. 2. Closed or Double End Machine.

Making Sheet-metal Screws

Form of Thread

The shape of the thread cut on the rolls is shown in Fig. 3, based on 1 pitch. That is to say, the space is 0.7 of the pitch; the thread 0.3 and depth 0.6; for example, with 4 threads per inch, the pitch is ¼ or 0.250 inch; the thread is $0.250 \times 3 = 0.075$ inch; depth $0.250 \times 0.6 = 0.150$ inch, etc. The thread should be nearly straight sided near the top, so that wear, which comes entirely on the tops of the thread, will only affect the center distance of the rolls and not the shape of the thread. The rolls have similar threads; the inside roll must be cut the same hand as is desired on the work, generally right, the outside roll must be the opposite hand. The inside roll must be an amount smaller than the work sufficient to permit easy removal of the threaded work without stopping the machine, yet not too small or there will be too great a difference in the circumference of the work and the roll, with the result that the work will have a different angular position for each revolution of the roll, and the thread on the work

or the portion of it already or partly formed will then have a different lateral position, becoming wider than desired. In other words, circumferential creep in a helix results in lateral displacement.

The Inner Roll

Best results will be secured by finishing up rolls, collars, etc., except for final threading of the inside roll. This is then threaded to a diameter equal to the root diameter of the work and the rolls set up and tried out soft; the right size can be found with a minimum of effort and time as the lathe and tools will be set up, to the one important variable.

The diameter of the outside roll should really be the same as that of the inner roll so that there will be no difference in the circumferential velocity and consequently no rubbing due to different surface speeds, but this cannot always be provided for on small work, as the spindles do not come close enough together, so that the outside roll is sometimes several times larger than the inner through necessity. Usually it is left somewhat larger than required so as to permit dressing when worn. The inner roll, however, will stand for only one or two dressings and sometimes none, depending on how much latitude the limit gages allow. Any difference in the diameter of the inner roll affects the fit of the thread, due to the creeping mentioned above.

Both rolls should be slightly taper, say just a few thousandths, which permits a neater fit, but still allows for slight variations in the stock; the cap then becomes slightly looser the more it is unscrewed, and there is less probability of caps sticking half way. When cutting the roll threads, rough out the space with a round-nose tool, somewhat deeper than required, as the bottom is clearance anyway, then finish the tops of the thread with a form tool; the tops of the threads only do the work. Harden both rolls and temper a straw, 450 to 460 degrees.

Points in Setting Up

The collars or end gages should run true and be securely fastened; on sheet work they should lap over the threaded portion of the roll to avoid cutting the thread to a shoulder. An apron is sometimes used at the inner roll spindle as a gage, but a collar is better, as it never grooves as badly and is always set correctly, if left on the roll where it belongs. When setting up, see that rolls and collars run true and bear fairly well; set the edge of the outside roll just inside the edge of the cap, so as to leave the edge slightly flaring and, therefore, easy to "catch" the thread when screwing onto the neck. If the roll is set even with the edge of the cap, or beyond it, the edge is turned inward at a certain place, making it easier to cross the threads than to catch them.

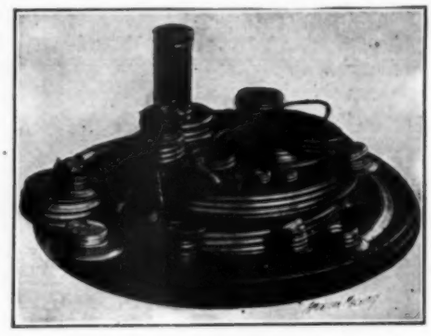


Fig. 4. Sheet-metal Screw Caps

The end collar should hold the work closely, but not tight enough to mar it. Pull the machine around by hand in the direction it runs and set the threads central by revolving one spindle independently of the other, and locking with all the back lash of the gears taken up. The depth the thread can be rolled depends on thickness and ductility of the stock and must be found by trial; but don't work to the limit. It is usual to thread cap and neck together when shape and thickness of stock allow. Other operations, such as nurling, trimming, crimping and beading are sometimes incorporated under favorable circumstances.

Production

Production depends a good deal on the size and nature of the work. As an example of developed specialization, a manufacturer of threading machines gives a production of 50 Mason fruit-jar caps per minute, threading and crimping in the porcelain liners, using a semi-automatic feed. A girl will easily assemble and thread 10,000 1-inch metal-polish necks and caps in 10 hours, on a plain machine.

Fig. 4 shows a few of the varieties of screws in my sample room. The large piece is a seamless can top of 15½ inches diameter with an 8¼-inch screw and cap made of IX tinplate. The smallest is an oval tooth-powder box top with 7/16-inch screw. The sample to the extreme left is a Mason fruit-jar cap with porcelain liner crimped in. The tall sample is a Colgate shaving-stick box, a neat example of press and thread work. The others are mainly syrup, honey, metal polish, copper flask and can screws. Only one of many square can tops with screws is shown; this being gold lacquered and poorly placed, shows indistinctly.

A School with a Real Working Shop

By Entropy

The other day I discovered a school that would do the hearts of your readers good. When I say discovered, I mean it in the generally accepted way. It may be better to say that I stumbled on it. Others may have discovered it at various times for it is well over a century old and its alumni are scattered all over New England and its suburbs. There is a little town which has accumulated around the school.

The town for the better part of the past century has looked up to the school, has boasted of it, has lived on its faculty and pupils. The pupils and the faculty realized all this and bought silk hats and swallow-tail coats.

Then they discovered that work was beneath them. They found that the higher order of intellect cannot labor over five hours per day and very few days at that. Thus the little endowment of the school began to dwindle. Then the faculty dwindled. The pupils followed suit. Finally all that was left was a group of noble buildings, some noble elms that refused to quit work, a sleepy town and an alumni of workers scattered the world over—and a mortgage.

You will say that this is nothing new, that it is to be seen in every sleepy college or academy town all over New England. But the remarkable thing is to be told. Bear in mind that this is and always has been a school where Latin and Greek have ruled and which has worshipped Yale and Harvard. This school proposed to have and has a shop. Not a machine laboratory, nor a manual-training shop or a place to hammer out brass candle sticks but a SHOP to turn out work to be sold for money—real money!

When an individual strikes rock bottom he has his choice—starve, beg, steal or work. When a school or college is in the same position it usually begs. This school proposes to work. It proposes to get pupils. There are not enough pupils who can pay its tuition so it proposes to let them work out their tuition just as my great grandfather worked out his $3 tax by working a week on the roads.

They say, "Here, young man, you have no money and you want an education. You can come into our shop during spare hours and we will pay you what you earn by remitting your tuition money. We will arrange your Greek and Latin and astronomy and biology so that your spare time will come in chunks and you can profit by it. And they propose to have their pupils earn their way and make a business of it, and when they have put themselves on their feet where they can walk

to church without wondering if they can spare a dime from their necessities for the contribution box, then, and only then, do they propose to go to their rich alumni and say, "See what we have done! Will you help us to do more?"

They are not doing this thing to train engineers nor machinists nor cabinet makers but to aid themselves in sending young men to college.

Incidentally they hope to train young men to do useful things by doing them. They propose that if they fail in college that they shall have something on which they can fall for a living and by the same token I predict that their young men who can and will earn their way will not fail to go through college.

The thing that speaks highest in my estimation is the fact that these people are running an old-line educational institution with roots and traditions that run back a century. They propose to sacrifice nothing of these traditions but they do propose to make doing a necessary adjunct to thinking and to put manual labor on a par with the dead languages, which is where it ought to be. Colleges where men can work their way through are the most useful.

A User's View of Machine Tools*

By John Riddell†

Some suggestions looking toward improvement in lathes, automatic screw machines and drills.

The problem of safe-guarding machinery and experience with muslin pinions—a new development.

*Abstract of a paper read before the National Machine Tool Builders' convention.

†General mechanical superintendent, General Electric Company, Schenectady, N. Y.

In the automobile industry, and in those factories having a very large output, there must necessarily be a great deal of repetition work, such as cylinders, valves, connecting rods, crank and cam shafts, transmissions, etc. It would seem that most of these parts should be made on very special tools.

In the Schenectady works of the General Electric Company, while we have considerable repetition work, we do not have anything to compare with the quantity of parts above enumerated. We have, indeed, a very large variety of parts which have to be machined, but the parts running into the greatest numbers are principally made by our screw-machine and punch-press operations, which, in many cases, run into the millions.

Lathes

The writer has been considering seriously for a number of years the advisability of having instead of standard engine lathes, simple turning machines, to produce such pieces as small shafts, which are required in more or less large quantities, but since there is a certain variation as to the dimensions in this class of work, we could not have our machines so very special that they could not be used for a general run of similar work.

It has been the practice for a long time, when if several lathes were required for any particular department, standard engine lathes would be purchased, which machines would be fully equipped with screw cutting, cross feed, rod feed, compound rest, large and small face plates, and very frequently, with an extra block for large outside turning. Many such machines have been purchased with the view of being transferable from one department to another as emergency would arise, and it was thought advisable on this account to have the machines as universal as possible. Experience has taught us, however, that an engine lathe once placed in one of our shafting departments would, in many cases, wear itself out before having to do any face-plate or chucking work, and very seldom, screw cutting. You can, therefore, see that the cross feed, as well as screw cutting, would be superfluous. Lathes for this work should be equipped with a powerful rod feed, and with a suitable friction device which would slip if the turning tool should meet with any obstruction, so as to prevent serious accident to the machine.

Such machines should be so designed that the screw-cutting attachment and cross feed could be readily applied, if in the future they should be required, which, in our case, would be in very rare instances.

Many attempts have been made to solve the problem of small shaft turning, with more or less success, but many of the machines designed for this purpose have been more or less complicated, which precludes the possibility of putting inexperienced men on to run them.

A lathe to be used exclusively for shaft turning, say from about 2 to 4 inches in diameter, would not require the range of speeds as for a standard engine lathe. A standard engine lathe of about 18- or 20-inch swing should be geared from about three or four revolutions per minute to about 600. The lathe I have in mind should have a range of speed of from about 20 to about 250 revolutions per minute for turning, and two or three higher speeds for filing and polishing. These speeds should possibly be between 450 and 600 revolutions per minute. It is desirable in our case at least to have such machines fitted for electric motors. The motors should have a speed variation of about two to one, which, with two or three gear changes, should give all the speeds necessary for a simple turning machine.

Automatic Screw Machines and Turret Lathes

The automatic screw machine, in a general way, is made so that six, seven, or eight operations can be performed on most any of them. A very large quantity of work going through them requires but two or three operations at the most, such as milling, threading, and cutting off. Many of the screw machines are so complicated that they will perform the operations whether the tools are actually working or not.

It would seem that machines could be very much simplified by making some do three or four operations only, and not encumber them with too many useless parts, or at least parts which will have to be running whether they are actually performing any useful work or not.

The same is true of some larger automatic turret machinery. Some of these machines are designed for boring and facing, but nevertheless, the turret will have five or six positions, all of which operations must be gone through with whether there are but one or two simple operations to be performed, at the loss of much valuable time.

Multiple Spindle Heads

A great deal might be done toward adapting multiple-spindle heads to single-spindle presses. It is very doubtful if, as at present constructed, it is good judgment to put in too many expensive multiple-spindle drills, for the reason that it takes so long to adjust them for a small number of pieces.

Radial Drills

Radial drills generally should be so stiffened up as to permit of only the smallest amount of spring to the arm. I believe more drills are ruined by the springing of arms, both under the actual pressure and when a drill is breaking through, than would be if it were not for the springing referred to, as, under the pressure of drilling the arm goes up, and when the pressure is relieved from the point the drills are forced through, and, in many cases catch on the lips and break.

Protective Devices and Wood-working Machines

We have had considerable trouble at the Schenectady works of the General

Electric Company lately, in trying to conform to the new State laws, which are very stringent as to the protective devices on machine tools in general and wood-working machines in particular. It is an exceedingly difficult matter to so protect buzz planers and circular saws as to guard against carelessness and the apparent indifference of the workmen, and if someone would devise proper ways and means for protecting such machines he would have the thanks and blessing of the whole manufacturing fraternity.

Accidents are frequently due to carelessness on the part of the operators, because, first, they will not take time to shut down their machines when making adjustments, for the reason that a spindle running 3000 or 4000 revolutions per minute would require an appreciable length of time to come to rest, and also to start again. This would suggest some suitable brake which would quickly and effectively stop such machinery without complicating it.

If an operator has a great many pieces of a similar kind to either saw, plane or shape, he may possibly take pains to apply such guards, which are usually provided, but if, as frequently happens, a man wants to plane one single piece or saw a strip from a board, he will not take time to adjust the safety appliance, and he is very apt to be caught. This would point out the necessity of having some suitable guards which would always be available no matter what the conditions were, and it would seem that people producing this particular line of machinery would conjure up something practicable and effective. As it is, the market is flooded with unsatisfactory devices, which in many cases are mere traps and generally do more harm than good; but the law says we must use something.

Punch Presses

Punch presses in general are very well designed, but they, like wood-working machinery, are comparatively dangerous to the fingers of careless or dreamy operators. We have in the Schenectady works of the General Electric Company several hundred of such machines, and have applied a great many safety appliances and devices, to protect the workmen against thoughtlessness, but it appears that no matter what we have been able to apply they are either taken off and thrown to one side or neglected in some manner so that sooner or later an operator is apt to get a finger pinched. This would suggest automatic feed mechanisms and something to take the piece from the dies after the operation is completed. There have been innumerable devices of this kind exploited, but nothing as yet seems to cover the ground fully.

Another defect in this class of machinery is the fact that in many instances when clutches and other parts come loose, due to wear, they are very apt to repeat the stroke. This frequently happens when a man's hand is between the dies. Such accidents should be impossible until the operator deliberately steps on the treadle.

Noise in Machine Shops

It has been pointed out that there is a great deal of gear noise in the machine shops of the present day. I am sorry to admit that this is true, but it is not wholly due to the fact that there are more gears used in the construction of machine tools, but is more especially due to the higher speeds at which machines are run today, as compared to ten or twenty years ago; as I mentioned before in reference to planing machines. Before the advent of high-speed steels 20 feet was considered to be a fair cutting speed for an ordinary steel shaft or a piece of cast iron to be either turned or planed; whereas today, we are actually turning shafts at from 75 feet to 125 feet per minute. So it will readily be seen that machines today are producing from three to six times more work than they did a few years ago; hence it should follow that there would be more noise due to machine tools producing this extra amount of work. These gear noises are very unfortunate but we hope by improved gear-cutting machinery and the use of various other materials which have recently been introduced, that this trouble will gradually disappear.

Muslin Pinions

We have introduced gears at our Schenectady works and pinions made of a high grade of muslin which have been applied to a great variety of uses. We have used one of them on a boilermaker's punch and shear which previously gave considerable trouble, not only on account of noise, but in the actual breaking of the gears; due to excessive back lash and flywheel action on the machine. We had such wonderful success with that particular pinion, which has been running now some two years, that we gradually extended the use until now we are using them on two 10-foot planing machines, which are operated by electric motors and compressed-air clutches, as intermediate pinions for the reverse motion. Heretofore we have tried various substitutes, including bronze, which would go to pieces in two or three weeks; steel would last longer, but made an intolerable noise; rawhide would seem to shrink and burn out quickly, and we very seldom could find anything that would stand the work longer than three or four weeks at the most.

It is perhaps too early to say much about the particular pinions in question, but they have at present been running four months and they have not yet begun to show any signs of distress, and it looks as though their life would be as long as the gears with which they mesh.

Test of Muslin Pinions

I might ask your indulgence while I describe what has recently been done with a pair of these pinions. As I said before, we have been using them some two years, and are gradually extending their use, and have now fitted up a large department at the Lynn Works of the General Electric Company where we can produce them in fairly large quantities, but before putting them out in very large quantities we desired to have a life test to destruction, and with this in view we rigged up two railway motors opposed to each other; one of which has a cloth pinion on the armature shaft running into a steel gear on countershaft. On the other end of this countershaft is another cloth pinion engaging with another large steel gear. The other side of this steel gear engaging a cast gun-iron pinion of the same dimensions as the cloth. This then connects with its shaft and gear to a rawhide pinion on the opposite motor. This particular motor is resisted by rheostats to load the motor which has the muslin pinion. In starting this test it was found that there were no results from a certain load. This load was gradually increased and when after stopping the motors to examine the pinions, through some oversight, an excessive overload was applied when they were again started. The shock was so severe that it broke about one-half of the teeth from the gun-iron pinion, leaving the two muslin pinions in as good condition as before. Another gun-iron pinion was put on, which also broke. A third was then put on and the load reduced, and the life test has now been running some two or three weeks, and will be continued until some of the gears actually wear out, and not break.

I point this out to show the actual strength of pinions made of this material. So we have reason to believe that with time the noises in machine shops will gradually disappear as they came, without, however, a corresponding reduction in output.

There are dozens of machine shops in the United States, and some of them very large ones, in which a goodly sum could be saved each year were the toilet rooms more conveniently arranged in a place where they would be more available. In some shops it is necessary for a man to go down stairs; in other shops they must go up stairs and in a certain shop the men must travel nearly 200 feet to the toilet rooms and back to their work again. It takes considerable time to do all this traveling. Just hold a watch on several of the men and note how long it takes them to travel down stairs and get back to work again. Assume a certain number of trips made by each man during a day, multiply the number of trips by the time required, multiply this by the number of days in the year and figure out the cash value of the time thus consumed.

Automobile Engine Proportions—IV

By A. G. Kessler
and G. W. Lewis

Cam shafts, cams and followers. Diameters of gas intake pipes and exhaust pipes. Calculations of gas and exhaust velocity allowed in present practice. Sizes of water pipes. Materials used for cylinders, pistons, rings, shafts, crank cases, gears and flywheels. Specifications and analyses of irons, steels and bronzes employed by best known builders.

Cam shafts for automobile engines may be made in two ways: (*a*) shaft and cams all in one piece, and (*b*) shaft and cams made separately, in which case the cams are fastened to the shaft by means of keys. The latter method has the advantage that the cams may be heat treated without the necessity of treating the entire shaft, which is both expensive and inconvenient. The length of the cam shaft, the placing of the cams, etc., depends entirely upon the arrangement of cylinders, valves and general motor design.

Data and formulas on cams and cam shafts are entirely empirical and the various items as found from practice will now be given.

Diameter of Cam Shaft

For various cylinder diameters it was found that the diameters of cam shafts for four- and six-cylinder motors were very much the same. The average diameter of cam shaft for both cases is given by the following equation:

$$D_{cs} = (0.139\ D + 0.27)\ \textit{inches}$$

where

D_{cs} = Diameter of cam shaft in inches.
D = Cylinder diameter in inches.

Cam-shaft diameters were found to vary between a minimum of 5/8 inch and a maximum of 1¼ inches.

Overall Length of Cam Shaft

Cam-shaft lengths depend upon the method of casting cylinders, whether separately, in pairs, in triplets, or in block, but formulas for approximate overall lengths may be given irrespective of the method of casting, in terms of the cylinder diameter. For four-cylinder motors the following applies:

$$L_{cs} = 8\ D - 8\ \textit{inches}$$

in which

L_{cs} = Overall length of cam shaft in inches.
D = Cylinder diameter in inches.

For six-cylinder motors, $L_{cs} = 10.7\ D - 8$ inches, where symbols have the meanings just given.

Cam Diameter or Diameter of Cam Base Circle

The diameter of cam, or so called cam base circle may be obtained from the equation:

$$D_c = (1\tfrac{1}{2}\ D_{cs} + \tfrac{1}{16})\ \textit{inches},$$

in which

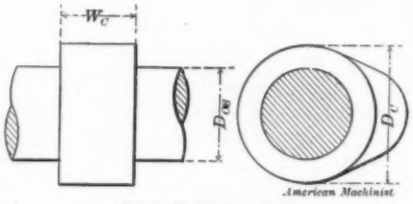
D_c = Diameter cam or cam base circle in inches.
D_{cs} = Diameter cam shaft in inches.

Approximate upper and lower limits for cam diameter may be found from

(*a*) upper limit, $D_c = (1\tfrac{1}{2}\ D_{cs} + \tfrac{1}{4})$ inches.

(*b*) lower limit, $D_c = (2\ D_{cs} - \tfrac{3}{4})$ inches.

These equations hold true only for camshaft sizes between 5/8 inch and 1¼ inches, these being the limits used in present-day automobile practice (approximately).



Cam Proportions

Width of Cam Face

For automobile engines the width of cam face varies between 7/16 and ⅞ inch, the average being given by

$$W_c = (\tfrac{1}{4}\ D_c + \tfrac{1}{4})\ \textit{inches},$$

where

W_c = Width cam face in inches.
D_c = Diameter cam or cam base circle in inches.

Diameter of Cam Follower

In some cases cams have flat followers, which as a rule are circular in form and slightly greater in diameter than the width of cam face. In the majority of cases, however, roller followers are used, varying in diameter between ¾ and $1\frac{5}{16}$ inches. A good average for all cylinder sizes gives a diameter of follower equal to 1 inch.

Clearance between Cam and Follower

To insure correct seating and total closing of the valves, there should exist somewhere in the valve mechanism a definite amount of clearance. This clearance is usually allowed between the base circle of the cam and the cam follower, or between the tappet and follower rods. It cannot, of course, be very great, as it means just that much lost motion in the valve mechanism; however, it should be sufficient to insure entire closing of the valve at the proper time.

On the majority of engines at present built, this clearance is either 1/64 or 1/100 inch. The maximum value given by some manufacturers was 1/32 inch, while in many cases this clearance seemed to be entirely neglected.

Gas and Water Pipes

The following material deals with the determination of inlet and exhaust gas pipe sizes, gas velocities in these pipes, determination of dimensions of water supply pipes, etc., for automobile engines.

Intake Gas Pipe

The horsepower of a motor is directly dependent upon the piston displacement of the engine, which in turn depends directly upon the amount of mixture taken into the cylinder through the intake gas pipe. Therefore the size of gas supply pipe was found to be a function of the engine horsepower.

$$D_{ip} = (0.027\ B.H.P. + 0.7)\ \textit{inches},$$

in which

D_{ip} = Inside diameter of intake pipe in inches (taken between the carbureter and inlet manifold).
$B.H.P.$ = Rated A. L. A. M. horsepower.

Having found the size of intake pipe for various horsepowers, it now becomes necessary to determine the velocity of mixture through this pipe. The quantity of mixture taken in through the gas supply pipe in cubic inches per minute is $Q = FV$,

where

Q = Quantity of gas taken in per minute.
F = Area of opening in square inches.
V = Velocity of gas in inches per minute.

Also

$$Q = \frac{\pi D^2 L}{4} \times \frac{N}{2}$$

cubic inches per minute where

D = Cylinder diameter in inches.
L = Stroke in inches.
N = Revolutions per minute.

But

F = Area of intake pipe in square inches $= \dfrac{\pi D_{ip}^2}{4}$.

D_{ip} = Inside diameter intake pipe in inches.

Therefore

$$V = \frac{Q}{F} = \left(\frac{\pi D^2 L N}{8}\right) \div \left(\frac{\pi D_{ip}^2}{4}\right) = \frac{D^2 L N}{2 D_{ip}^2}$$

velocity in inches per minute, if the gas flows steadily for the entire minute.
Or

$$V = \frac{D^2 L N}{24 D_{ip}^2}$$

in feet per minute, if the gas flows steadily for the entire minute. The above equation is only approximately true for single-cylinder motors since in this case it can hardly be said that there is a steady flow of gas, and it therefore gives values slightly lower than actual.

In the case of four-cylinder motors, there is four times as much mixture taken in per minute and as the flow here is practically constant the following equation will apply:

$$V = \frac{4 D^2 L N}{24 D_{ip}^2} = \frac{D^2 L N}{6 D_{ip}^2}$$

in feet per minute. This equation is accurate because with four cylinders acting one at a time, the flow of gas in the pipe is fairly constant.

For six-cylinder motors the flow may also be taken constant and in this connection the following equation may be used:

$$V = \frac{6 D^2 L N}{24 D_{ip}^2} = \frac{D^2 L N}{4 D_{ip}^2}$$

in feet per minute.

The preceding method for determining gas velocity may therefore be used as shown in the following type example.

Example—Assume bore = 4½ inches, assume stroke = 5 inches, number of cylinders = 4. Then for 1000 feet piston speed per minute, the revolutions per minute will be 1200. And (from the A. L. A. M. formula)

$$B.H.P. = \frac{D^2 N}{2.5} = 32.4.$$

From the equation previously given for intake pipe size, a motor of 32.4 horsepower will require an intake pipe $1\frac{9}{16}$ inches inside diameter. Then substituting in the formula for velocity, given above for four-cylinder motors, the following results are obtained:

$$V = \frac{D^2 L N}{6 D_{ip}^2} = \frac{(4\frac{1}{2})^2 \times 5 \times 1200}{6 \times (1\frac{9}{16})^2} = 8300$$

feet per minute, or approximately 140 feet per second.

It will be found by making a series of checks similar to the above, that the velocity in the intake pipe is approximately the same as that through the valve opening. In other words the flow is at a more or less constant rate all through the intake side of the motor. The average velocity through valve ports was found to be about 130 feet per second.

Size of Exhaust Pipe

The size of exhaust pipe is taken just beyond the exhaust manifold and is also given as a function of the rated A. L. A. M. horsepower of the engine,

$D_{ep} = (0.031\ B.H.P. + 0.9)$ *inches,*

in which

D_{ep} = Inside diameter exhaust pipe in inches, taken just beyond the exhaust manifold.

$B.H.P.$ = Rated A. L. A. M. horsepower.

Gas velocity in the exhaust pipe can be calculated just as was shown under gas intake pipe, by substituting for the intake pipe diameter the proper exhaust pipe diameter.

Then the velocity for

(a) Four-cylinder motors only equals $\frac{D^2 L N}{6 D_{ep}^2}$ in feet per minute.

(b) Six-cylinder motors only equals $\frac{D^2 L N}{4 D_{ep}^2}$ in feet per minute.

A series of calculations for exhaust gas velocities showed that the gas in the exhaust pipe traveled somewhat slower than on the intake side, averaging between 50 and 60 feet per second, or between 3000 and 4000 feet per minute.

As a matter of fact, the exhaust gases are very hot and are under considerable pressure, due to this heat, at the instant of release, so that the volume of the exhaust gases is much greater than the cylinder displacement. As the temperature is not accurately known, and would only complicate the problem, the above method of calculation is adopted, although the real gas velocity is much greater. This is why the apparent exhaust gas velocity is kept so low in comparison to that of the intake.

Water Supply Pipes

The following data on water supply pipes apply only to motors in which the water system is operated by a pump. The pipe size given is at the discharge side of the pump, or between the pump and the engine.

For 4-cylinder motors the following average water-pipe sizes may be employed:

For

D = 3, 4 and 5 inches

D_p = ½, ¾ and ⅞ inch,

in which

D = Cylinder diameter in inches,

D_p = Inside diameter water pipe in inches, at discharge of pump or between the pump and the engine.

For 6-cylinder motors the average pipe sizes at present in use are as follows:

For

D = 3, 4 and 5 inches,

D_p = ¾, 1 and 1¼ inches, where symbols are as previously given.

Materials Used. Cast Irons

The cast iron used for cylinders and pistons must have special properties to meet the conditions required of these engine parts. These properties are:

(*A*) The cast iron must be close grained and finely crystalline.

(*B*) The metal must be hard enough to keep the wear down to a minimum, but not too hard for easy machining.

(*C*) It must have a low freezing point, so as to make the metal flow freely and entirely fill the mold.

(*D*) It must have a maximum tensile strength of at least 25,000 pounds per square inch.

(*A*)

The finely crystalline or close-grained structure of cast iron is obtained by causing the metal to cool quickly, thus preventing the segregation of ferrite, graphite, etc. Cylinders and pistons are quite thin and this fact aids in the formation of the desired iron structures without making artificial cooling necessary. The structure obtained is not, as is often stated, a gray iron, but a half-white or semi-gray iron.

(*B*)

The softness of the iron depends upon the amount of silicon and ferrite in the iron. The hardness depends upon the amount of combined carbon, which is directly dependent upon the rate of cooling. In order that the cast iron should not be too hard for ready machining, the maximum allowable percentage of combined carbon should not exceed 0.7 per cent. for these castings.

(*C*)

The temperature at which the cast iron freezes is affected by the amount of phosporus in the metal. Too great a percentage of phosphorus, however, makes the metal cold short; that is, brittle when cold. The proper percentage of phosphorus to be used is from 0.4 to 0.5 per cent.

(*D*)

The strength of the cast iron depends upon the purity of the material and the absence of blow holes, cinders, etc. The metal is purified by the addition of manganese, which removes the sulphur, gases and other impurities and thus increases the total carbon content of the iron. The strength decreases as the amount of graphite increases; hence it is necessary to keep the total carbon low in order to keep down the graphite. To keep down the total carbon requires the addition of steel scrap or the use of an air furnace.

An average analysis for *cylinders and pistons* for automobile engines is given as follows:

Total carbon = 3.1 per cent.
Graphite = 2.5 per cent.
Combined carbon = 0.6 per cent.
Silicon = 1.8 per cent.
Sulphur, less than 0.08 per cent.
Phosporus = 0.5 per cent.
Manganese = 0.7 per cent.

For *piston rings* a slightly different

analysis may be used for the average case, not varying greatly from that used for cylinders and pistons. In many analyses, however, the per cent. silicon was considerably higher, the maximum being about 2.95 per cent.

Total carbon = 3 per cent.
Graphite = 2.25 per cent.
Combined carbon = 0.5 per cent.
Silicon = 1.7 per cent.
Sulphur, less than 0.08 per cent.
Phosphorus = 0.4 per cent.
Manganese = 0.50 per cent.

For *flywheels* a good average analysis is given by the following:

Total carbon = 3.35 per cent.
Graphite = 3 per cent.
Combined carbon = 0.35 per cent.
Silicon = 2.3 per cent.
Sulphur, less than 0.08 per cent.
Phosphorus = 0.4 per cent.
Manganese = 0.60 per cent.

The analysis for flywheel iron shows that it will be high in ferrite and silicon, resulting in a soft gray cast iron, which admits of easy machining and finishing.

Steels

The steels used in the manufacture of automobile engine parts may be divided into three general classes:

(*a*) Open-hearth steel, for case-hardening and for general use.

(*b*) Open-hearth steel, required to be tough and stiff but not to be case-hardened.

(*c*) Nickel steel.

Class (*a*)

This steel should have a maximum strength = 50,000 to 60,000 pounds.

A yielding strength from 30,000 to 35,000 pounds.

Ductility 30 to 40 per cent.
Reduction of area 30 to 60 per cent.
The average analysis of this class is,
Carbon = 0.15 to 0.25 per cent.
Sulphur = 0.05 per cent., or less.
Phosphorus = 0.05 per cent., or less.
Manganese = 0.5 to 1 per cent.

Steel with these constituents is mild and very easily and quickly machined, which, of course, is a material advantage in the process of manufacture. The heat treatment of this class of steel consists of pack hardening, which in general is performed as follows:

The steel is packed in cut bone, the latter being contained in iron pots the covers of which can be sealed with clay. The whole is then heated in a furnace to a temperature of 1500 degrees Fahrenheit and kept at that temperature from six to nine hours, depending upon the depth of metal to be carbonized. This depth varies from 1/32 to 1/16 inch in the average case. Care should be taken in packing that the material to be hardened is completely surrounded by the bone.

The material is then allowed to cool in the pot, being finally reheated and quenched in oil or water of a temperature from 1375 to 1475 degrees Fahrenheit, depending upon the hardness of surface required.

In case-hardening gears or cams integral with cam shaft, only a certain part of the surface is required to be carbonized. The surfaces not to be treated may be protected by copper plating, and care being taken to surround with bone only the surface to be hardened. In many cases the machined parts are quenched in oil as soon as they are removed from the pots, thus saving the cost of reheating. The quenching temperature is usually between 1400 and 1500 degrees Fahrenheit.

Under this treatment come the following engine parts: Cams, when made separate from the cam shaft; nuts, studs, washers, rocker arms, wrist or piston pins, tappet rods, cam followers, and in fact all moving parts where the wear is excessive and a hard surface with high resilience is required. This includes surfaces requiring ability to withstand shock loading.

Class (*b*)

This steel should possess the following physical properties: Maximum strength, 65,000 to 70,000 pounds; yield strength, 40,000 to 50,000 pounds; ductility, 25 to 33 per cent.; reduction of area, 40 to 50 per cent.

The following is a good average analysis:

Carbon = 0.25 to 0.4 per cent.
Sulphur = 0.05 per cent. or less.
Phosphorus = 0.05 per cent. or less.
Manganese = 0.06 to 1.0 per cent.

Engine parts made of this steel are: cam shafts, cap screws, studs, nuts, and valve guides.

Class (c)

The greatest use of nickel steels is in machine parts that are under repeated stresses, as crank shafts and valves.

The addition of from 3.5 to 3.75 per cent. nickel to an ordinary carbon steel will increase its elastic limit 40 to 50 per cent., with a decrease in ductility from 15 to 20 per cent. Its most important property, however, is that its life in resistance to repeated stresses is increased nearly six times that of ordinary carbon steel.

An average analysis follows:
Carbon = 0.18 to 0.28 per cent.
Sulphur = 0.04 per cent., or less
Phosphorus = 0.04 per cent., or less
Manganese = 0.60 to 1 per cent.
Nickel = 3.5 to 3.75 per cent.
Copper, not to exceed 0.2 per cent.

Nickel steel is used for crank shafts, cams, valves, valve-operating mechanisms, etc. It possesses the advantage that it requires from two to three hours less time in the furnace for pack hardening than ordinary carbon steel.

A metal used extensively for bearings, especially at the wrist- and crank-pin ends of connecting rods, also for tappet-rod guides and bushings, is phosphor bronze. Its average composition is as follows:

Copper = 88.6 per cent.
Tin = 10 per cent.
Lead = 1 per cent.
Phosphorus = 0.40 per cent.

In many engines manganese bronze, similar to Parson's bronze, is used, containing:

Copper = 58.06— per cent.
Zinc = 39.79 per cent.
Tin = 0.99 per cent.
Iron = 0.24 per cent.
Aluminum = 0.52 per cent.
Manganese = 0.40 per cent.

Materials for the Various Parts

Crank Shafts

The majority of crank shafts for automobile engines are drop forgings belonging to classes (b) and (c) previously given. In some cases special steels as chrome-nickel and vanadium steels are employed. When made from chrome-nickel steel, the crank shaft is usually cut from a solid bar or ingot.

Connecting Rods

These again consist principally of drop forgings, belonging to classes (b) and (c), and in some cases are made of manganese bronze or steel castings.

Wrist or Piston Pins

Pins are made of materials under classes (a) and (b), case hardened—as explained under class (a). In some cases steel tubing is used, being a cold-rolled steel with from 0.2 to 0.3 per cent. carbon, case hardened.

Valves

(1) With disks and stems integral.

In this case the material generally consists of a drop-forged nickel steel, containing about 3½ per cent. nickel. Occasionally ordinary carbon steel, with about 0.5 per cent. carbon, is employed.

(2) Disks and stems separate.

Here, the disk is generally made of high-nickel steel or cast iron. Valve stems are made of high-carbon steel to resist wear. They are electric welded to the nickel-steel valve disk, and threaded into the cast-iron disk and headed over.

The following nickel steel is sometimes used in making valves:

Nickel = 35 per cent.
Carbon = 0.2 per cent.
Silicon = 0.1 per cent.
Sulphur = 0.01 per cent.
Phosphorous = 0.01 per cent.
Manganese = 0.30 per cent.

This material is practically an "Invar" metal, in that its coefficient of expansion and contraction, due to change of temperature, is practically zero.

Gears

Gears for cam shafts are made of bronze, cast iron, steel and in many cases raw-hide gears are used. The principal

requirement to be met is quiet running, and so far, the most satisfactory results have been obtained from cast iron on raw-hide, and bronze on raw-hide.

The best grade of transmission-gear blanks generally are made from drop-forged crucible steel containing from 0.18 to 0.24 per cent. carbon. After cutting they are carbonized by pack hardening, to a depth of from 1/32 to 1/16 inch, then being reheated to a temperature of about 1475 degrees Fahrenheit and quenched in oil.

In case gears are made of bronze, the composition generally is:

Copper = 88 per cent.
Tin = 10 per cent.
Zinc = 2 per cent.

Keys

These are made of a high-grade crucible steel, containing about 0.80 per cent. carbon. They also are pack hardened and then heated above the critical temperature (1450 degrees Fahrenheit) and quenched in oil or water.

Crank Cases

Crank cases may be made of pressed steel or cast iron, but in the majority of cases the material used is aluminum, with the following average composition:

Aluminum = 92 per cent.
Copper = 7 per cent.
Zinc = 1 per cent.

This material gives a maximum strength 20,000-25,000 pounds.

A yielding strength of 15,000 pounds.
Ductility = 5 per cent.
Reduction of area = 5 per cent.

Do Gear Hobbing Machines Cut Flats?

By F. O. Farwell*

A defense of the gear-hobbing machine, fortified by a novel and striking experiment.

George B. Grant in his article, "Why Gear Hobbing Machines Cut Flats," page 1148, Volume 33, Part 1, contends that gear-hobbing machines cut flats; Walter Groocock in his article, "Are There Flats on Generated Gear Teeth," page 411, shows in quite as convincing a way that gear-hobbing machines do not cut flats, while P. A. Thompson in his article, "Why Gear Hobbing Machines Cut Flats," page 458, assumes the existence of flats, but contends that they are so minute that in practice they really do not count.

Mr. Grant acknowledges that the "sample" gears cut by the manufacturers are "flatless," but he insinuates that this is accomplished by some trick. He says: "The manufacturers are perfectly willing to cut sample gears for a prospective customer, and said samples will be flatless. How do they do it? I think I know" . . . "I used to say there were tricks in all trades except the gear trade, but now, on further consideration, I am forced to admit that a few have crept in recently from outside."

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If there is any "trick" in hobbing flatless gears, we do not know of it here at the factory with which I am connected. This firm has been quite aggressive in soliciting sample gear cutting, and they have cut a great many samples as well as quantities of gears on orders, and if any flats were ever discovered we have never heard of it.

EXAGGERATED EXAMPLES UNFAIR

The "greatly exaggerated example" shown in Mr. Grant's article would almost lead one to believe that these flats did exist and that they were so pronounced in actual practice as to be discernible to the naked eye, or to be detrimental to the smooth, quiet running of the gears, or at least that they are discoverable if magnified. It would be just as fair to try and prove that it is bad practice to mill flat surfaces by showing a "greatly exaggerated example" of milling, in which a fly cutter was made to gouge out a single deep hollow, as to show the "greatly exaggerated example" of Mr. Grant to prove the existence of flats. Of course, we can assert that there is nothing perfect. There was never anything turned or ground perfectly round; there was never anything planed or milled or ground perfectly flat. What we really want to know is—can gears be cut by the hobbing process that will run as smoothly and as noiselessly as gears cut by any of the slower processes? If flats exist in hobbed gears, hills and hollows exist in gears cut with single cutters and for precisely the same reason.

FIG. 1. HOB AND GEAR IN MESH

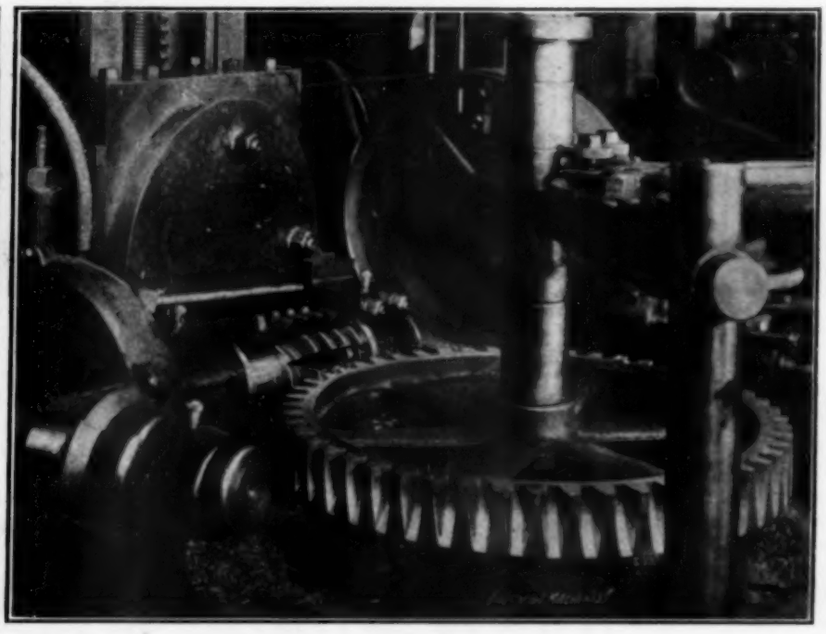


FIG. 2. PARTIALLY HOBBED GEAR

GEARS CUT BY ANY PROCESS HAVE MINUTE DEFECTS

Gears carefully cut by either process will have tooth-side surfaces that appear to be perfectly smooth curves, free from flats and ridges and free from hills and hollows. Such gears roll together smoothly. The tooth sides when slightly worn show a smooth, polished surface, free from bright streaks which would indicate hills—yet theoretically these defects (if they are not too minute to be called defects) do exist, just as the flat surface finished by a milling cutter is composed of a series of hollows gouged out by the teeth of the cutter, and hills caused by the work being fed along before the next tooth of the cutter does its work.

The periphery of a milling cutter or the ends of the teeth reach the finished line only when the tooth reaches the center line of the cutter. The side of a face mill or the straight-side milling cutter will remain on the finished line during the entire contact of the cutter and work. The sides of the tooth of a hob are at a comparatively slight angle and they approach in action the side teeth of the face mill. This feature will be referred to later.

Mr. Grant says, in describing the "utter impossibility" of a true hobbed tooth: "If they are true on the pitch line, they are too full everywhere else. The reason for this is plain. The hob tooth reaches the true surface of the tooth it is cutting only when it reaches the true center of the tooth space, and it can thus center only when it is at the common center line, the line that is normal to both the axis of the gear and the axis of the hob."

If hobbed gear teeth when true on the pitch line are too full everywhere else, how is it that a pair of hobbed gears will show no looseness on the pitch line or fullness elsewhere? They may be meshed to run with perfect freedom and with absolutely no lost motion at any point.

To illustrate, Mr. Grant says: "Take two cylinders, call one the gear blank and the other the hob and see if you can get them to touch each other when not parallel in more than one point, and that point on the common normal to both axes. The same law governs right through the work."

The illustration of the two cylinders is not analogous with the meshing of a hob or worm with a spur gear.

Fig. 1 shows a hob in mesh at the same angle it was run when cutting the gear. There is contact at six points as numbered. The points of contact would, of course, gradually shift as the hob and gear were revolved, each tooth of the hob taking a shearing, rolling cut on the finished line of the tooth.

Now the sides of the hob tooth having a comparatively slight angle, approach

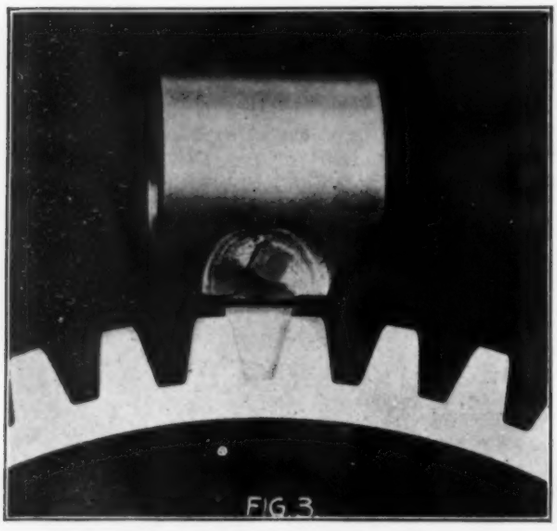


FIG. 3.

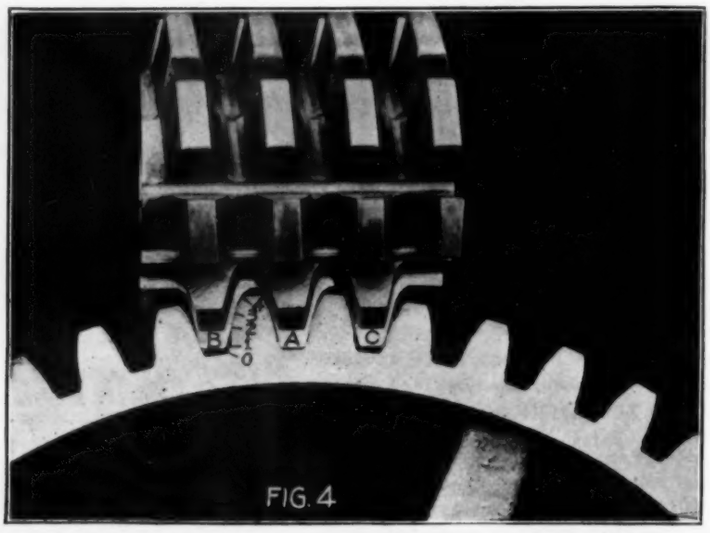


FIG. 4.

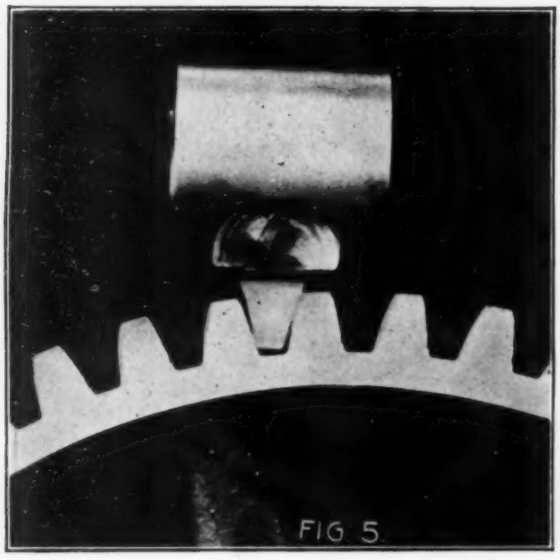


FIG. 5.

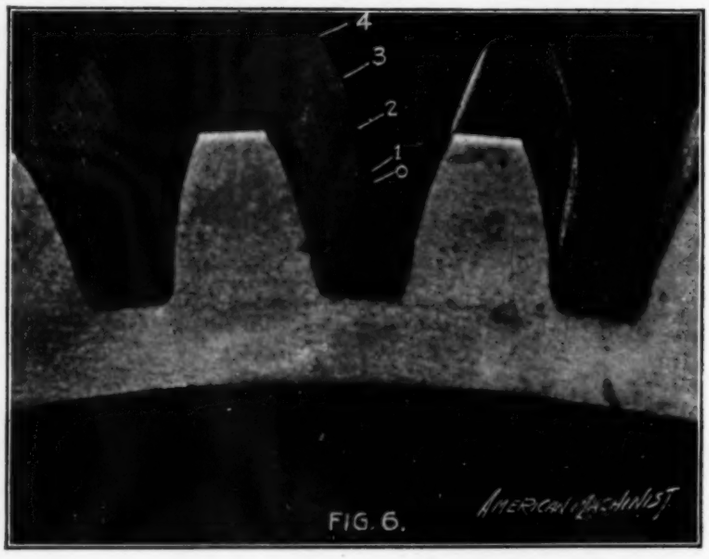


FIG. 6.

PROOF OF THE ACCURACY OF HOBBED GEARS

the true surface or finished line of the gear tooth so gradually that in practice the hob is actually finish-cutting the gear tooth for a measurable distance before reaching this center line and also after passing this center line, and as the gear is revolving at this time the cut taken by the hob tooth is a shearing, rolling cut, producing a curve and not a flat.

The bottom of the space cut by the hob tooth will show decided tooth marks or revolution marks, particularly with fast feeds, but the sides of the tooth are free from this, no matter how fast the feed.

To return to the "flats." If flats do exist, one would expect to find them in their most pronounced form in coarse-pitch gears in which the hob would have the fewest number of teeth in comparison with its diameter. Mr. Grant says: "If the cutter teeth are very far apart and on a cutter of small diameter, the flats will be very prominent." The little experiment submitted herewith was, therefore, made with the coarsest-pitch hob at hand, which was three pitch 4½ inches diameter, 4 inches long and had a total of 34 teeth. In this example, 27 teeth made contact with the finished line of the gear teeth as near as the writer could tell.

A Partially Hobbed Gear

A blank which was of proper size for 51 teeth were cut in the usual hobbing-process way. The cut was full depth (although for the best results I advocate a roughing and finishing cut), and the feed was continued until one-half inch of the face of the blank was cut to finished depth, as shown in Fig. 2.

The hob was then removed and a fly cutter the same size and shape of a hob tooth was placed on the hob arbor, centered properly and the remainder of the cut taken with this fly cutter or single-tooth hob. The gear and fly cutter were then removed and photographed, as shown in Fig. 3.

The space is several thousandths wider than the cutter at the bottom and the tooth sides are slightly curved, although the cutter sides are straight (except for the slight curve which the hob makers give their hobs to relieve the points of coarse-pitch gears).

The gears and fly cutters were then returned to the machine and the single-tooth cutter moved to the left of the center, just the lead of the hob. This would represent another tooth of the hob as tooth *B*, Fig. 4. Fig. 5 shows the gear with the fly cutter in the position for this cut.

A third cut was then taken with the fly cutter in position to represent tooth *C* of the hob in Fig. 4.

In Fig. 4, we have a gear cut, not with the hob shown in mesh with the gear, but with a single-tooth cutter in three positions, as *A, B, C.*

A Real Exaggerated Example

As a rule, I do not take much stock in "exaggerated examples." However, I will present one exaggerated example. In Fig. 6 is shown this 3-pitch gear exaggerated by the photo-enlarging process. The size is exaggerated; the roughness of the surface is exaggerated, but the object was to exaggerate these flats and ridges, so they could be seen, of possible.

The face of the gear to the front was hobbed to finished depth with the hob as shown in Fig. 2. The rear of the gear was cut with the fly cutter in three positions, as described. Yes, there is a discoverable ridge at 2 and 3, separating, not flats but curves, 1-2 from curve 2-3 and curve 2-3 from curve 3-4.

Evidently a hob having only three teeth would not produce gears acceptable to the modern high standard demanded. Still they are not such horrible examples as Mr. Grant would lead one to expect. They would be runable and, if not hardened, I doubt not in a short time a pair of these gears would have worn off the slight ridges 2 and 3 and would run as quietly as some of the gears turned out by gear-cutting concerns for the automobile trade.

However, there are, in practice, between tooth *B* and tooth *C* on this 3-pitch hob, 18 teeth, and at each end, as shown in Fig. 1 are other teeth, some 27 in all, each of which would take a rolling, shearing cut on end or on one or both sides, to remove the corner at *O* to obliterate the slight ridge at 2 and 3, and to blend these curves into one smooth, flatless, ridgeless curve, of a shape to enable a pair of gears whose teeth are produced by this process, to run more smoothly than those cut by any other process of which I am familiar. There are no tricks necessary to cut flatless gears by the hobbing process.

We must acknowledge, of course, that very poor gears may be cut on a very good hobbing machine. This usually happens because of a lack of ordinary care and judgment, rather than because of ignorance of any trick of the trade.

Precautions Necessary for Good Work

One of the most prevalent causes of bad work is the improper securing of the gear blank against vibration in the direction of its axis or the direction of the cut. The strain is almost entirely in this direction and not in a direction toward the center of the gear. The proper way to secure any gear blank, whose diameter is over four times its bore, is to place a ring upon the work table and supporting the rim of the gear near its periphery. Blocking, such as shown in Fig. 2, will answer quite well, but where there are many gears of the same size to be cut, the ring should be provided.

The support for the upper end of the work arbor should never be depended upon, except for small diameter gears of very wide face, or in cases when they are stacked several inches high in cutting. Dull cutters will, of course, produce bad work on any tool. Shift the position of the hob frequently and grind often and little at a time is the "trick." Inaccurate setting of the hob spindle head is the probable cause of many bad hobbed gears. The angle of the hob thread often is expressed by seconds as well as minutes and degrees, while the reading of seconds on any ordinary protractor is impossible. The slightest error in angle will cause the hob to crowd, tending to turn the blank on its arbor. Provision should be made to eliminate error in setting this angle as well as for setting for depth of cut.

In cutting gears of chrome-nickel, vanadium and other hard steel alloys, at least twelve-thousandths should be allowed for the second cut on 6-pitch gears and other pitches in proportion. If the second cut is merely a scraping cut and not enough stock is removed to let the cutter get a real chip, the cutter may glaze over and gouge under in spots, particularly if there is any slight longitudinal motion to the hob arbor or to the table-driving worm gearing.

Provision should be made so that the slightest lost motion in these parts can be easily taken up. If it is necessary to disassemble any part of the machine to make adjustments, they will be neglected. A wrench, a moment's time and a little good judgment to not overdo the thing is all that should be necessary to keep the vital points of a good hobbing machine in good adjustment.

Any metal-cutting tool which does its work intermittently, as does the punch and shear, the shaper, the milling machine and the gear-cutting machine, should be extremely compact and rigid in its connection between the cutter and the work acted upon. The design of these machines usually calls for G-shaped construction with an open side; the top of the letter usually supporting the cutter and the work being held to the cutter by the lower part. If the gap is unnecessarily large or there is much overhang to the cutter support or it is composed of many possible lost-motion joints, or does not contain sufficient metal in its construction, spring is sure to result, and broken punches, fined shearing, untrue planing, chattering milling and imperfect gear teeth will result.

Tons of cast iron in the base of the machine will avail nothing. Hold the cutter to the work and it will do the business.

New Automatic Can Machinery

The E. W. Bliss Company, of Brooklyn, N. Y., has recently added to its line of can machinery, several new designs of machines for the more economical manufacture of crimped, or packers; and open top, or sanitary cans. Some of these machines are here illustrated.

Fig. 1 shows a high-speed, top and bottom press. This press takes up to, and including 3-pound top and bottom dies. The strips, in packs, are placed in the holder shown on the left side of the machine, from which they are automatically fed by the auxiliary suction feed, to the carrier feed, which grips and carries them through the press. This carrier feed is arranged for a wide range of adjustment without additional parts, and with it, it is possible to secure any desired width between cuts. The machine operates at a high rate of speed, all parts being guarded against danger to the operator.

Fig. 2 shows the automatic double seamer. This machine is entirely automatic, and has been designed specially for double-seaming filled cans. The can stands still during the seaming operation. The filled cans with tops in place, are put into the carrier, which feeds them into the dial by which they are automatically carried under the revolving head, and sealed. After being sealed, they are automatically carried off, and roll into a chute. Four double-seamer rolls are used. Each operation is accomplished by two rolls acting simultaneously at opposite points of the cover, balancing the pressure, lessening the twisting tendency, and doing the work twice as fast as could be done with one pair of rolls.

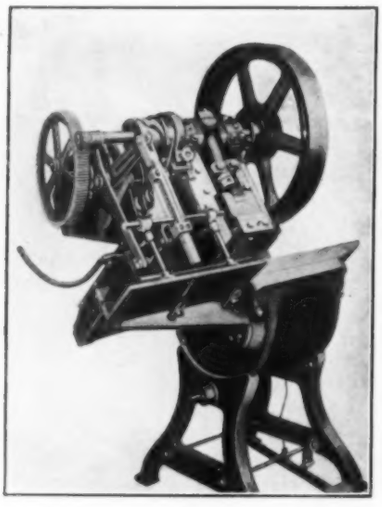


FIG. 1. HIGH-SPEED TOP AND BOTTOM PRESS

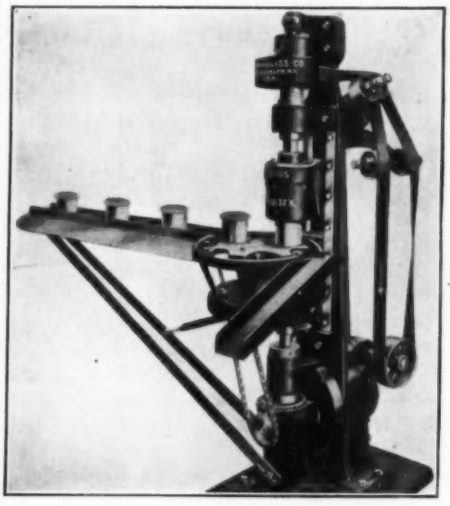


FIG. 2. AUTOMATIC SANITARY CAN DOUBLE SEAMER

The rolls are actuated by a circular, tapered wedge, uniformity of pressure being an adjunct to uniformity of seam. The compactness of the seaming head is an important feature of this machine, and a worm-wheel drive is used to do away with noise and vibration.

In Fig. 3 is shown the lap seam body making and soldering machine. The body blanks, which are previously cut in a gang slitter or shear, are placed in packs in the receiver of this machine, where they are separated by a mechanical, positive blank separator. From the receiver, the blanks are automatically fed into the machine by a conveyer feed, and after going through the preparatory former, they pass on and are clamped by the traveling horns, in which they are formed, and held during the soldering and wiping operations. After these operations they are automatically removed from the horn. This machine is constructed without intermittent motions; all motions are by crank action to reduce noise and vibration at high speed.

An improved cooling device with which this machine is arranged, does away with cooling belts, tending toward compactness.

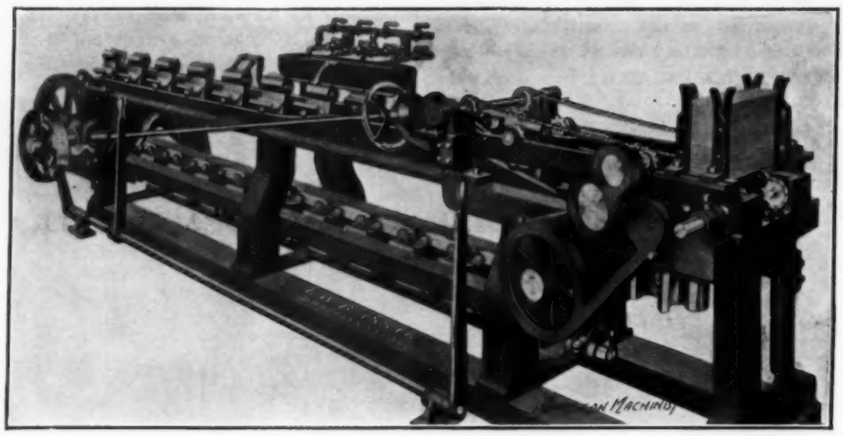


FIG. 3. LAP SEAM BODY MAKING AND SOLDERING MACHINE

Speed of Masses Thrown by Boiler Explosion

The *American Locomotive* is responsible for a short article tending to throw light upon the initial velocity with which parts of exploded boiler shells must have been projected, in order to have traveled the horizontal distance to the place where they have landed.

Neglecting the air resistance, the piece starting with a given velocity, would cover the maximum horizontal distance if its initial direction was 45 deg. to the vertical. Below, or above this, the piece would fall short of the maximum travel, or else it must have had a greater initial velocity. It is then correct to assume that a velocity calculated upon the basis of the 45 deg. angle is the *minimum* that it could possibly have had to land where it did. The initial velocity if the start was at 45 degrees, would then be expressed by the formula:

$$V = 1\sqrt{32\,D},$$

where V = velocity in feet per second, and D = horizontal distance traveled. If, then, a piece is picked up 600 feet from the boiler house, its initial velocity must have been at the very least; $1\sqrt{32 \times 600} = 139$ feet per second, or about 95 miles per hour.

Passage through intervening roof or walls, and air resistance, would mean that its velocity must have been considerably in excess of even this figure.

Teaching of Trades in Schools

The belief that trades cannot be successfully taught in schools is so prevalent that we are glad to publish a record of success which has been sent to us by John M. Shrigley, president of the Williamson Free School of Mechanical Trades. This record speaks for itself and it is as follows:

We are glad to be able to present the following record of the class graduated March 26, 1910, within six months after graduation:

The class had 51 members, 50 of whom answered our detailed inquiries as follows:

Trade.	Average Hours per Week Employed.	Average Rate of Compensation per Hour.	Average Weekly Rate of Compensation.	Number at Trade
12 Bricklayers	51	40.5	$20.64	All, and all like it.
13 Carpenters	51.6	30.6	15.81	All like the trade and all but one working at it. He followed the trade some time, but is temporarily inspecting material in auto works, and will return to trade later.
4 Operating Steam and Electrical Engineers	61.7	20.6	12.75	All, and all like it.
11 Machinists	55.7	26.0	14.53	All, and all but one like it.
10 Patternmakers	54.6	30.3	16.58	All like the trade and all working at it but one who is at mechanical drawing.

General averages:—

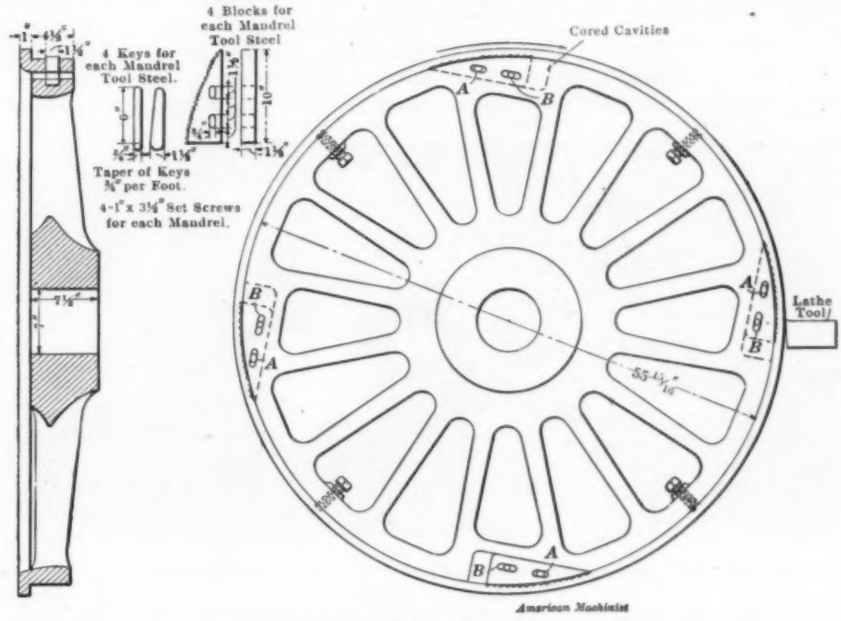
Hours per week employed 53.79
Rate per Hour ..... 30.80c.
Weekly rate of compensation $16.60
One not heard from—Carpenter—whom we learn indirectly is at mechanical drawing.

Our courses are based upon purely instructional methods and can be applied to either abstract or concrete exercises. We use about half of each and adhere rigidly in all work to the orderly sequence of development. We have also learned from many sources that the general academic and normal training given here has resulted in a high type of citizenship, and that our graduates for years past have easily assumed the duties of responsible positions.

A New Driving Wheel Mandrel

By Charles Markel *

The attached blueprint shows driving-wheel tire mandrel which has been tried out at this shop and given good satisfaction, both as to the time required to apply the tire to mandrel and the positive drive of the four steel notched dogs.


4 Blocks for each Mandrel Tool Steel
4 Keys for each Mandrel Tool Steel.
Taper of Keys ⅜" per Foot.
4-1" x 3⅛" Set Screws for each Mandrel.
Cored Cavities
Lathe Tool
American Machinist

56-INCH TIRE MANDREL

The present method of turning loose tires is by set screws in the mandrel or by shrinking the tires on temporary wheel centers. The first method is very unsatisfactory, as it takes time to set the tire and the set screws will not hold the tire against the cut that modern wheel lathes will pull. The shrinking-on material (gas or gasolene) costs money and the enlargement of tire which is caused by it being expanded every time it is turned, is an objection.

The mandrel shown on print should be cast steel and made as light as possible for convenience in handling. The one-inch rim shown acts as flanged when rolling on track, and also squares the tire sideways when face of tire is placed against it. The four set screws are used to center the tire on mandrel and take the strain between the four dogs. The four notched dogs do the driving and will pull the heaviest cut without any slip.

To apply tire, drive four keys *A* into keyways *B* which draws the four steel-toothed blocks down flush with mandrel face. Next place tire on mandrel with face of tire against the rim on mandrel, which adjusts the tire sideways. Then take keys *A* from keyways *B* and place them in keyways *A*, which draws the steel-toothed blocks up against the tire fit, and when lathe tool is started in cut on tire the steel blocks will naturally slide up on the tapered incline and will positively drive the tire. The tire can be placed on mandrel in ten minutes. A patent has been applied for.

*Shop foreman, Chicago & Northwestern Railway.

Some Shops in Cologne—Erratum

In the article under the above heading, which appeared at page 481, Volume 33, Part 2, dealing with the Gasmotorenfabrik Deutz, mention was made of universal work holders or vises, system Sulzer. Crediting the turning tables as the Sulzer system was in error, they being of the Wolfensberger system, developed and patented by F. Wolfensberger, manager of the Deutz shops.

Heat Treating High Speed Tools—I

By C. P. Berg *

Establishing the relation that exists between the hardening temperature and the life of high-sp ed steel tools. Also establishing a guide for the rapidity of heating when heat treating, by using heat-absorption tests.

Determining the degree of temper that gives different steels the maximum cutting efficiency, the hardness produced and results obtained from several physical tests.

In past years the heat treatment of metal-cutting tools made from high-speed steel has been practically all guesswork. Statements concerning the tempering of high-speed tools have generally covered such a wide range of temperatures, that the minimum would leave the tool far below its best hardening heat, while the maximum, on several brands of steel, would completely ruin the tool for work, by burning. Experiments were therefore undertaken to obtain the relation between temperatures used in hardening and the life of tools.

Fully appreciating the value of specialists for the various tests required to complete this work, I was fortunate in being associated with, and assisted by the following experts, each of whom carried on a special part of the investigation: W. C. Post, A. D. de Pierrefeu and J. H. Critchett, of the Chicago Metallurgical Laboratory, in connection with the metallurgical examination by photomicrographs; James Lowrie, with the hardness test, and W. V. Young, of the Hoskins Manufacturing Company. I am also indebted to the Link-Belt Company, at whose shops the cutting tests were performed.

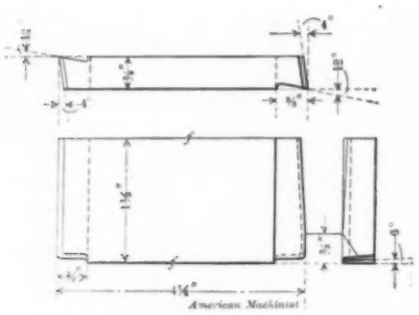


FIG. 1. SHAPE OF TOOL USED

*Production engineer, Link-Belt Company.

	A.	B.	C.	D.
Carbon.....C.	.70	.56	.74	.67
Silicon.....Si.	.211	.248	.262	.278
Sulphur.....S.	.016	.035	.016	.010
Phosphorus....P.	.010	.012	.016	.015
Manganese....Mn.	.27	.20	.21	.22
Chromium....Cr.	4.76	5.54	5.80	3.30
Tungsten.....W.	15.15	8.45	10.94	15.37
Nitrogen.....N.	.005	.005	.004	.015

TABLE 1. CHEMICAL COMPOSITION OF STEELS USED.

NATURE OF EXPERIMENTS

My work was: First; to establish a guide as to how rapidly the steel should be heated under the high-heat treatment, by heat-absorption test.

Second; to determine at which degree of temperature in the heat treatment, the maximum cutting efficiency occurs for a steel of a certain chemical composition.

Third; to give the reason for the relations found by these tests by metallurgical examinations and to illustrate the same by photomicrographs.

Four prominent high-speed steels, of the chemical composition shown in Table 1, were selected to be experimented upon. The steels were marked A, B, C and D, and these marks will be retained in referring to the four series of specimens undergoing the various tests.

TOOLS AND CASTINGS USED

In order to eliminate the effect of forging upon the high-speed steels tested, straight tools were decided upon for boring or inside turning and these were ground to shape and to standard angles in a grinder.

From the four previously mentioned steels, bars ⅜x1½ inches were cut off and made into tools for roughing cuts in boring cylinders to 4½ inches diameter. The tools were treated and ground with a cutting edge on both ends and to cutting angles, as shown in Fig. 1.

The cylinders that the tools were made to cut were cast in iron of a chemical composition that produced exceptionally hard castings. In order to insure equality, the greatest care was taken in preparing the molds for these castings; and all were poured from the same heat.

In view of the fact that the life of a tool decreases with the increase of combined carbon in the castings on which it is used, and that the amount of combined carbon is dependent upon the rapidity with which the cast iron is cooled after pouring it into the mold, it became necessary to find some method by which these castings could be cooled in the same length of time.

The molds were therefore specially arranged for this purpose, and eight minutes after the iron was poured the cores were removed and the castings cooled in water. This gave the castings as nearly as possible the same amount of combined carbon.

The dimensions of the cylinders were as follows: Outside diameter, 8 inches; length, 8 inches; and diameter of core, 4 inches. Fhom these ½ inch of metal could be removed by the double-end tools to be tested, giving ¼-inch depth of cut for each end of the tool. Only sound castings were used in the tests.

HEAT-TREATING INSTRUMENTS

The temperatures used in the heat treatment of tools have, heretofore, generally been measured, in practice, by the terms; cherry red, bright yellow, white, etc. These measurements of heat were probably as correct as any other in connection with the old-time method of tempering tools in the blacksmith forge, where no accurate control of the heat could be obtained.

The modern electric furnace, with its perfect control, evenly distributed heat and reducing atmosphere, and the ther-

FIG. 2. ELECTRIC HEATING FURNACES AND SWITCHBOARD

mo-electric pyrometer for measuring temperatures, have caused the science of treating metal-cutting tools to take a long step forward. This kind of apparatus was, therefore, used in the tests made. It is shown in Fig. 2, together with the rest of the apparatus in the demonstrating room of the Hoskins Manufacturing Company, which is where this part of the work was done.

To the left can be seen the muffle furnace *A*. This was used for preheating the steel slowly up to 1400 degrees Fahrenheit prior to transferring it to the tube furnace *B*, for subjection to the high-heat treatment.

The muffle furnace *A* is of the wire-resistance type, and is constructed for temperature up to 1800 degrees Fahrenheit. The tube-chamber design of furnace *B*, where the experimental tools were subjected to the high-heat treatment, is constructed for temperatures up to 2600 degrees Fahrenheit.

Pyrometers

The current for both of these furnaces is controlled on the switchboard *C*. This also carries the thermo-electric pyrometer *D*, which is connected with the thermo-couples by the switch *E*. The temperatures in several furnaces can be read on the one pyrometer by turning this switch; the contact points of which are numbered to avoid confusion.

The insure accuracy the pyrometers used were calibrated before and after the readings made on the temperatures of the test specimens. The calibrating consisted of taking a reading on water at the boiling point (212 degrees Fahrenheit), on aluminum at the melting point (1215 degrees Fahrenheit), and on copper at the melting point (1949 degrees Fahrenheit).

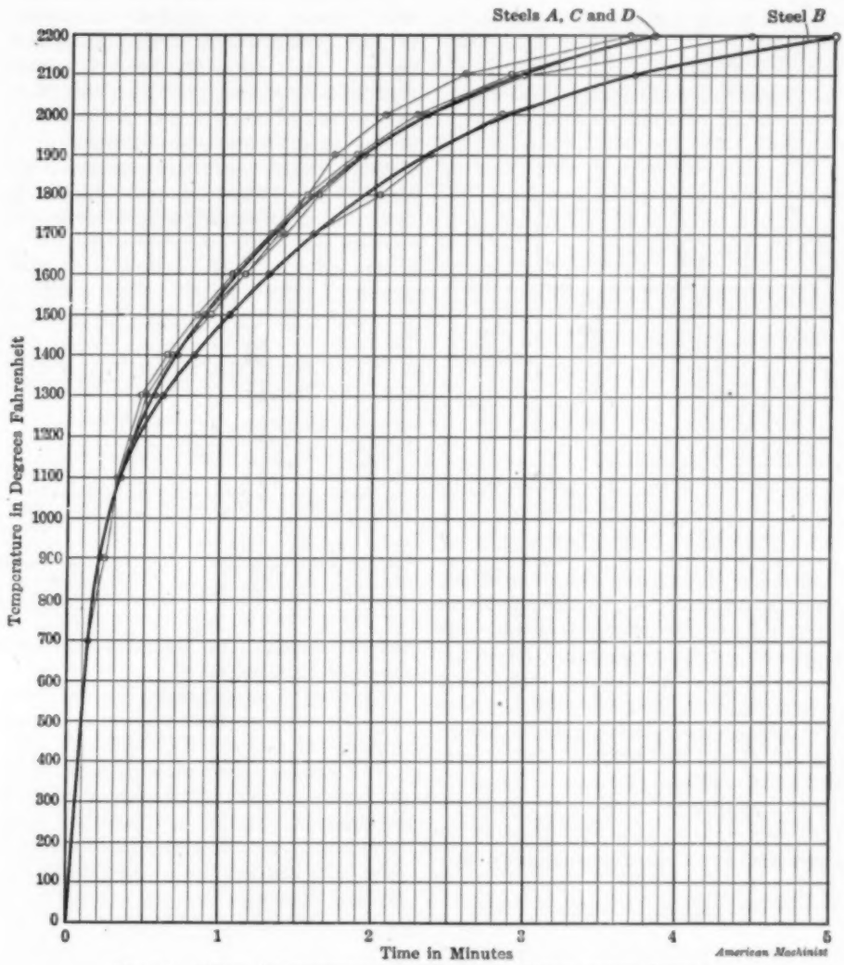


FIG. 3. HEAT ABSORPTION OF THE FOUR HIGH-SPEED STEELS

In giving high-speed tools the high-heat treatment, the temperature should be raised rapidly to the desired degree, for quenching, but enough time should be allowed for the heat to penetrate thoroughly to the center of the tool, which otherwise would be in danger of cracking.

To do this, it is necessary to know the length of time that the tool under treatment requires to absorb the heat to which it is subjected. In order to ascertain this for a guide in treating the experimental tools, the heat-absorption test was made, from which the results are shown by the diagram in Fig. 3.

Four pieces of steel of equal size (⅜x1½x1½ inches), one from each of A, B, C and D steels, were prepared with a hole to receive the end of the thermo-couple, as shown in Fig. 4.

Heat Absorption

The furnace was run up to 2200 degrees Fahrenheit, and kept at this temperature. The test pieces were placed in the furnace individually and time observations were taken on the increasing temperature.

From the uniformity of the curves, in Fig. 3, it will be seen that the molecular change, which is so great in the carbon steels as to stop the increase in temperature for a time sufficient to be recorded (Recalescant Point), did not at any point disturb the evenly increasing temperatures of the specimens up to 2200 degrees Fahrenheit. As will appear later, it was found that some of these steels are treated with the best results at 2150 degrees Fahrenheit. The molecular change evidently is not violent enough and quick enough to stop the increase of temperature in the steel. At least it could not be observed by the instruments used.

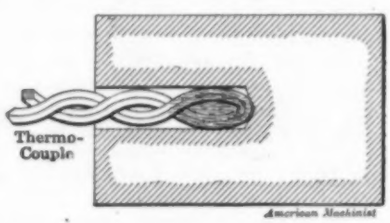


FIG. 4. THERMO-COUPLE CONNECTION TO STEEL

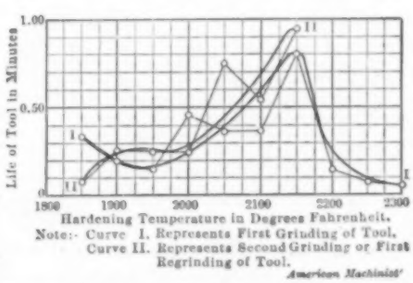

Life of Tool in Minutes
Hardening Temperature in Degrees Fahrenheit.
Note:- Curve I. Represents First Grinding of Tool.
Curve II. Represents Second Grinding or First Regrinding of Tool.
American Machinist

FIG. 5. RELATION BETWEEN TEMPERATURE AND LIFE OF TOOL OF SERIES A

From other tests made on heat absorption with various sizes of steel, it appears that the time for the absorption of heat increases very nearly in proportion to the thickness of the steel. Thus, a piece of steel ¾ inch thick requires twice as long a time as is shown by the diagram in Fig. 4, which is of steel ⅜ inch thick. This would be 6.6 minutes for a temperature of 2150 degrees Fahrenheit for any one of the A, C and D steels.

A scleroscope hardness test was made of six specimens of steel A, that were fractured to show the grain, after having been heated to 2150 degrees Fahren-

heit. These were left in the furnace for 2, 4, 6, 8, 10 and 12 minutes, respectively, after reaching this temperature and were then quenched in oil at 100 degrees Fahrenheit. A comparison of these fractures with the ones from the experimental tools, and the results from the physical tests of the latter, would strongly indicate the necessity of careful observation of the time that tools should remain in the furnace to become thoroughly and uniformly heated.

The results are shown in the following table.

Specimen.	Time Left in Furnace.	Hardness by Scleroscope.
1	2 minutes.	80
2	4 "	79
3	6 "	78
4	8 "	68
5	10 "	79
6	12 "	70

TABLE 2. EFFECT ON THE HARDNESS OF TIME OF SUBMISSION TO HARDENING HEAT.

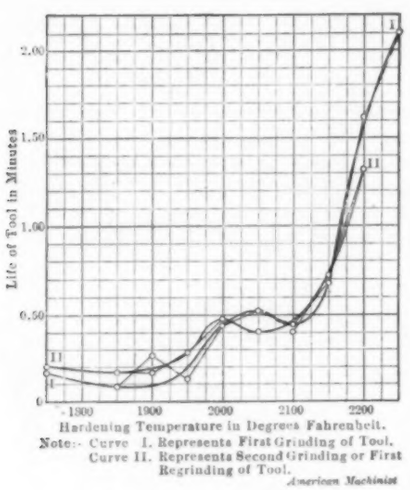


FIG. 6. RELATION BETWEEN TEMPERATURE AND LIFE OF TOOL OF SERIES B

HEAT TREATMENT OF TOOLS

Based upon the above results, the heat treatment of the experimental tools was undertaken.

In order to get the reading of the temperature of the steel itself, a loop of 3/64-inch wire was put around one end of two specimens, which were to receive an equal amount of heat. The loop was made loose enough to permit of moving apart the two free ends of the specimens. A wedge-formed space was thereby obtained between them, in which the end of the thermo-couple was held firmly, yet from which it could be easily removed.

The specimens were preheated slowly to 1400 degrees Fahrenheit, and from this heated to the various degrees of higher temperature shown in Table 3. At the temperatures indicated in the table, the specimens were quenched in oil, which was kept constant at 100 degrees Fahrenheit. For convenient comparison, the results of hardness tests with the scleroscope have been shown.

Specimen Marked	Steel Marked.	Quenching Temperature Degrees F.	Hardness, by Scleroscope.
1	A	1850	78
2	A	1900	81
3	A	1950	76
4	A	2000	78
5	A	2050	81
6	A	2100	82
7	A	2150	83
8	A	2200	81
9	A	2250	77
10	A	2250	77
0	A	2300	74
11	B	1850	78
12	B	1900	74
13	B	1950	75
14	B	2000	77
15	B	2050	83
16	B	2100	83
17	B	2150	82
18	B	2200	79
19	B	2250	78
20	B	1750	76
21	C	1950	78
22	C	2050	80
23	C	2100	80
24	C	2150	83
25	C	2200	80
26	C	2250	75
27	C	2300	73
28	C	2350	..
29	C	2325	71
30	C	2350	68
31	D	1950	70
32	D	2050	75
33	D	2100	76
34	D	2150	81
35	D	2200	79
36	D	2250	83
37	D	2300	86
38	D	2350	86
39	D	2300	86
40	D	2400	84

TABLE 3. HEAT-TREATMENT OF TOOLS AND THEIR HARDNESS.

Specimen 0, of series A, softened and caved in on one side. Specimen 28 of series C softened so the free end (not supported by the tongs) tore off in removing it from the furnace. Specimen 30 was taken to replace the broken one. Special precautions were made in removing this from the furnace, and it was quenched without mishaps.

The specimens receiving maximum heat, without exception, all fused at the ends, and some were considerably softened.

PHYSICAL TESTS

A 34-inch vertical boring mill was selected from the cutting tests, so the chips would clear away from the tool easily. The ends of the cylinder were faced, to eliminate the scraping of any scale that might be on the surface, by the experimental tools. This made the physical conditions for the tests as near equal as possible, and yet closely resembling the conditions of every-day shop practice.

The life or durability of the tools appeared to vary a good deal, both according to the chemical composition of the steel and the temperature.

SERIES A.

The results of the cutting test made with the steels of series A are plotted in Fig. 5.

It should be noted that the specimens quenched at the temperatures above 2150 degrees Fahrenheit, failed almost immediately and broke.

The second curve (II), which represents the second grinding of the tool, shows a slight increase in durability.

The cutting speed of 80 feet per minute; the thickness of the chip, or feed per revolution, of 0.0339 inch; and the depth of cut of ¼ inch at each end of the tool, were kept constant for all specimens and for both grindings.

SERIES B

The results obtained from the cutting tests made with steels of series B are plotted in Fig. 6. These curves do not present a great deal of uniformity at the low temperatures, but improve and become more distinct as the temperature increases.

The specimen (19) receiving the highest heat showed the maximum durability, but it failed very suddenly and broke into several pieces. The fractures gave evidence of brittleness.

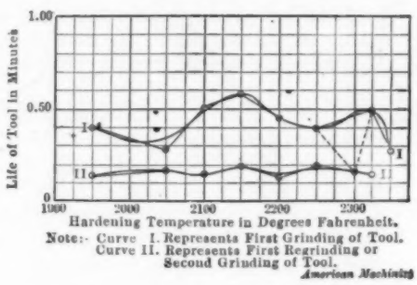


FIG. 7. RELATION BETWEEN TEMPERATURE AND LIFE OF TOOL OF SERIES C

Practically no difference in durability appears between the first and second grinding of the tool.

The cutting speed of 80 feet per minute; the thickness of the chip or feed per revolution of 0.0339 inch; and the depth of cut of ¼ inch at each end of the tool, were kept constant for all specimens and for both grindings.

SERIES C

The results obtained from the cutting tests made with the steels of series C are found plotted in Fig. 7.

The cutting speeds were evidently too high for this grade of steel. The durability was very low at all points and the variations were not distinct. However, it will be seen that the durability attains its maximum at 2150 degrees Fahrenheit in curve I, representing the first grinding of the tool. The dotted lines show that the specimen (27) which was quenched at 2300 degrees Fahrenheit, failed and broke almost immediately after starting.

Curve II, representing the second grinding of the tool, does not show any variations whatever, and the difference between this and the first grinding is

negative. Both these occurrences are directly due to an increase in cutting speed, of 20 feet per minute, for the specimens on second grinding.

The cutting speed of 80 feet per minute for first grinding, and 100 feet per minute for second grinding; the thickness of chip or feed per revolution of 0.0339 inch; and the depth of cut of ¼ of an inch at each end of the tool, were kept constant for all specimens.

Series D

The results obtained from the cutting tests made with the steels of series D are shown in Fig. 8. In this diagram it may be noted that part of the specimens were subjected to another test after being ground a third time.

All three curves (I, II and III) show the variations very distinctly, and exceptionally high durability, with the attained maximum at the quenching temperature of 2350 degrees Fahrenheit for both the first and the second grinding.

The specimen (40) quenched at 2400 degrees Fahrenheit broke on the second grinding after failing in the length of time (0.52 minute) shown in the diagram.

Only part of the specimens were run on the third grinding, simply for the

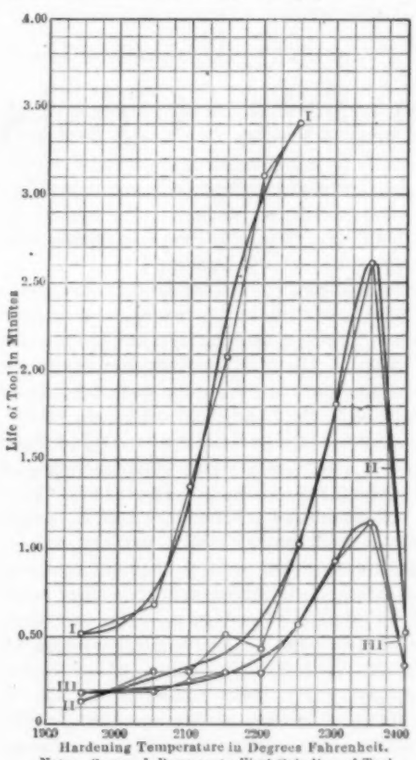


Fig. 8. Relation Between Temperature and Life of Tool of Series D

reason that the time for boring one cylinder would not be sufficient for the tool to fail at a cutting speed of 80 feet per minute. Cutting on more than one cylinder with the same tool would cool the cutting edge of the tool while changing, and the result could not be considered.

The cutting speed of 100 feet per minute for the first and second grinding, and 80 feet per minute for the third grinding; the thickness of chip or feed per revolution of 0.0339 inch; and the depth of cut of ¼ inch at each end of the tool, were kept constant for all specimens.

Percentage Comparison

In Fig. 9 is shown, by percentage, the relation between temperature and life of tool, of the four series of specimens. The temperature forms the base of the diagram, and the ordinate is made into a per cent. scale.

The maximum life or durability of the tool is taken as the unit or put at 100 per cent. and the durability in percentage of the maximum can be read from the curves for any temperature used.

If the series A be taken as an example

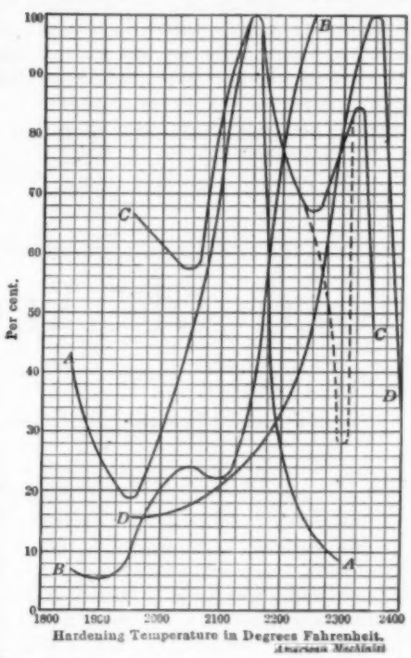


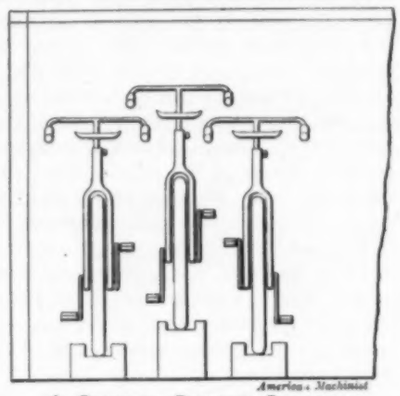
Fig. 9. Relation Between Temperature and Life of Tool by Percentage

it appears that a specimen tempered at 2000 degrees Fahrenheit only has a durability of 30 per cent. of the maximum, tempered at 2100 degrees Fahrenheit, it has a durability of 73 per cent. of the maximum and at 2200 degrees Fahrenheit 27 per cent. etc.

A Compact Bicycle Storage

The storage of bicycles in large numbers becomes quite a problem in some manufacturing plants, necessitating the resort to double-deck houses and stands which are not convenient places in which to handle wheels.

The sketch shows a simple plan for economizing space as practised by the Rodney Hunt Machine Company, Orange, Mass. Every other runway is raised about six inches above the lower level so that the handle bars lap over each other as shown and save considerable space



A Compact Bicycle Storage

when many wheels are to be stored. It also saves money in building the storage shed for a given number of wheels.

Exit of the Open Oil Hole

Machines turned out nowadays by the most progressive manufacturers show no open oil holes whatever. Each and every place where lubrication is required, if not inclosed for reservoir lubrication, is served by some form of oil or grease cup. There are no more open holes to be filled with oil and dirt to the great detriment of the journal which is unfortunate enough to be located thereunder. There is no longer any excuse for the oiler to break off the tang of a file in an oil hole when he is digging a hole through the accumulated dirt therein.

The little compression grease cup with which most heavy bearings are now fitted serves to give most excellent lubrication with a minimum of lubricant and attention. It requires much less time to "oil around" with compression grease cups than with the squirt can and the spring-top oil cup. Only a slight turn of the cup cap is necessary and the oiling is accomplished, and no further attention is required until time for the next oiling. The filling of grease cups can be accomplished in a very short time, and by the use of a simple tin cup and plunger arrangement.

It is conceded by all lubricating engineers that perfect lubrication is secured when a very small quantity of the lubricant is applied continually to the bearing, and it must be admitted that the well designed grease cup, filled with grease adapted to the bearing, comes very near to filling the rôle of the ideal lubricant—so near indeed, that nobody is able to point out the difference in the amount of friction and the lubricant consumed.

The grease should be most carefully selected for that particular service and bearing to secure the best possible results.

S. Bend, Ind. I. F. Hobart.

A Simple Apprenticeship System

Editorial Correspondence

The plan which the Baldwin Locomotive Works, in Philadelphia, have used for nine years. Unusual conditions for both shop and school instruction make such a simple system possible.

The apprenticeship system which has been practiced by the Baldwin Locomotive Works, in Philadelphia, Penn., for the past nine years is extremely simple and has worked well in their case. During that time some 1300 boys have been apprenticed, about 250 being employed at these works at the present time, and there are over 60 graduates occupying good positions in various departments.

Boys of 17 or thereabouts are apprenticed by contract, for a four-year term, with an hourly wage rate of 7, 9, 11 and 13 cents for the four years. Every boy who completes the course receives a bonus of $125 in cash.

Unless the boy has been through high school or is fairly well equipped with a knowledge of mathematics and mechanical drawing, he is required to attend night-school sessions, provided by the public school for such cases, or private classes, such as those of the Franklin or Spring Garden institutes. There are no hard and fast rules in regard to this, each case being considered from the standpoint of the individual, the object being to secure results rather than to enforce arbitrary rules which can never fit all cases, and which are nearly always sure to cause irritation and dissatisfaction.

Much of the work in the Baldwin Locomotive Works is done by contract, each contractor selecting his own men and being responsible for their work. The boys are apportioned among the contractors, whose duty it is to instruct them in the class of work they are doing, and the more valuable the boy becomes under their instruction, the greater profits accrue to the contractor. Discipline, however, is entirely in the hands of the foreman who oversees the work of the contractors.

The boys are moved from one department to the next every three months, so that they may secure a knowledge of the various kinds of work, which gives them an excellent opportunity to become all-round machinists, which is not always possible in modern manufacturing establishments.

The apprentices are in charge of N. W. Sample, who looks after the boys' interests. After a contractor has taught a boy so that he becomes a substantial producer he very naturally would prefer to keep him instead of having him transferred to the next department. Matters of this kind are looked after by Mr. Sample, who sees that justice is done to all concerned and so keeps the system moving smoothly.

This is a very different solution of the problem than that usually found, but it seems to work very satisfactorily The conditions are somewhat unusual, but this system seems to meet the requirements of the case. There is a growing belief in most quarters, however, that better results can be obtained by giving the necessary school instruction in the daytime than at night.

The Importance of Accurate Costs

By Holden A. Evans*

"The day will come when no manufacturer who has a permanent growing success can have that success without a complete and accurate cost system." One trouble today is that cost systems are considered as shop secrets and are not open to free, intelligent criticism. There is too much guesswork, too little knowledge.

*Naval constructor, United States Navy.

Many manufacturing establishments throughout the country have excellent cost systems, and in the majority of these the value of costs is well understood and the data obtained from the cost records are utilized to their full value. On the other hand, there are far too many establishments in which little use is made of costs other than in fixing selling prices, and in some cases costs are not obtained.

Cost Keeping for Manufacturing Establishments Comparatively Simple

The most accurate cost systems are usually found in establishments where but few classes of standard articles are manufactured. This is readily explained, as it is comparatively easy to devise a satisfactory system for such an establishment, and it is so simple that it is difficult to go wrong in its application. Moreover, the cost of maintaining such a system is small. Accurate cost keeping in its simplest form may be applied to the manufacture of a single class of standard articles. As the number of classes is enlarged, particularly if the products vary greatly, cost keeping becomes more difficult and expensive. Notwithstanding this, nearly all strictly manufacturing establishments have fairly satisfactory cost accounts.

Repair and Jobbing Shops Present Difficulties in Cost Accounting

In a jobbing shop or in a combined manufacture and repair shop accurate cost keeping is not simple. The principal difficulty experienced is the proper distribution of the expense burden. It is, therefore, natural that the worst examples of cost keeping should be found in these classes of shops. In some of these establishments attempts are made to obtain accurate costs, but in the great majority the results are not worthy of the name of cost records. Little is known of the advantages to be gained by accurate costs, and there is comparatively little interest shown in the subject. In many of the smaller establishments the owner or manager has risen from the shop and he knows little or nothing of modern accounting. When he worked in the shop the cost record consisted of the time books. Such an owner or manager has a horror of red tape, and to him modern cost keeping is red tape to an extreme degree. Under these conditions it is not surprising that accurate cost records in jobbing repair shops are very rare.

Accurate cost keeping is very difficult in a large ship yard which is engaged both on new work and repair work. There are numerous independent shops in such an establishment which vary greatly in equipment and in the class of the products. It is necessary that the costs should be known not only by the many jobs included in the whole, but also by shops, and by the classes of labor employed. The proper distribution of the overhead burden is also exceedingly difficult. These questions will be discussed in detail in a later issue.

Inaccurate Costs among Manufacturers Making Standard Articles

Accurate costs are sometimes not obtained even in establishments where more or less standard articles are manufactured. The report of the cost committee of the National Machine Tool Builders' Association contains the following signifi-

cant statement: "Machine tool manufacturers making similar and competitive machine tools discovered among themselves ruinous and unprofitable competition, based, presumably, on actual costs. Comparisons soon showed, however, that even where there were fair cost system methods, important and appreciably large elements were treated by different manufacturers in different ways."

This is a polite way of stating that some of the members of the machine-tool builders' association did not obtain actual costs, in that they omitted some of the important elements that go to make up total costs. These makers were selling their goods below cost and were demoralizing the entire business. They, however, did not know this; they undoubtedly considered that they were making a fair profit, when suddenly they found themselves face to face with bankruptcy. If these conditions exist in the manufacture of machine tools, is it to be wondered at that the ship yards, where cost keeping is far more difficult, do not know their costs? Is it surprising that the thousands of jobbing repair shops do not know what cost keeping means? The machine-tool builders were aroused by the gravity of the situation. They appointed a committee which devised a uniform cost-keeping system which can be successfully employed by all makers of machine tools. No doubt this system is not used by all machine-tool builders, but the report of the committee was widely read and studied by them and general interest was created in the importance of accurate costs. This brought beneficial results, and the costs now recorded more nearly represent actual costs.

Unfortunately no uniform cost system can be devised for the various manufacture and repair plants throughout the country. The successful system must be developed for each class of work and adapted to meet local conditions. There are, however, fundamental principles of great importance which are applicable to all systems. These principles are violated in thousands of establishments, and until this is corrected actual costs are impossible. It is of importance to every manufacturer, it is to the benefit of every stockholder in an industrial establishment, that interest should be awakened in cost accounting, and that accurate costs should be obtained in every manufacturing shop and every repair shop in the country. Just so long as costs are not known there will be the same ruinous competition that existed in the machine-tool trade.

Lack of Knowledge of Costs Disturbs Trade

The competition which is most feared by a well conducted establishment is that of the establishment which does not know its costs. It is often the case that a well conducted efficient establishment which has figured on a moderate profit is far underbid by a less efficient establishment, and the work taken at a price below actual cost. It is no satisfaction to the efficient establishment to know that the successful bidder will soon go into bankruptcy, for there will be someone else in the field with as little knowledge of real costs. These conditions demoralize business and they will continue until actual costs are known. This situation explains what otherwise might be considered remarkable variations in bids submitted for the same work by a number of establishments located in the same vicinity and working under approximately the same conditions. It is not unusual to see such bids vary from 50 per cent. to 100 per cent.

In a large repair job which recently came under my observation, the specifications of the work were in great detail, and called for exactly the work to be accomplished. The bids that were received ran all the way from $425,000 to $517,000. I recently obtained bids on some small cast-iron cylinders, rough machined, for small engines. These ran from 6 cents to 21 cents per pound.

A few years ago it was not unusual for bids on battleships to differ by as much as half a million dollars. This enormous difference did not represent difference in efficiency of the ship yards, nor difference in the cost of labor or material, nor difference in the figured profits. It was almost entirely due to lack of knowledge of actual cost of similar battleships previously built. It was due to these causes that large contracts for warships were taken at prices far below cost, and consequently several yards were forced into bankruptcy. These experiences have taught their lessons and there are few of the ship yards that do not now know at least their total costs on each contract.

In small shops, however, the lesson is not so quickly learned. A shop goes under here and there, but the real cause is not known, and another takes its place, and there always seems to be enough shops without a knowledge of costs to keep business disturbed. On the Pacific Coast these conditions prevail at present, and there is little prospect, except through luck, of the most efficient shop, which has figured on a moderate profit, securing a contract where bids are required. It is fortunate for these that many contracts are placed without requiring bids. Not only would accurate cost keeping prevent this demoralization of business, but it points the way to more efficient production.

Why Are There So Few Accurate Cost Systems?

The present condition of affairs is difficult to explain, as competition is keen and the American manufacturer is progressive. In many cases the owner or manager has risen from his tools and his success is due to his intimate knowledge of the work and his ability to direct shop operations. When the plant was small he figured his own costs and made his estimates for new work. With his ability and his intimate knowledge of every detail of the work he was able to do this with considerable accuracy. His plant has now grown beyond the one-man stage. The costs are kept by men who have no shop experience, and estimates for new work are made by men who have neither the experience nor the ability of the manager and are based on the cost records of previous similar work. The manager does not realize that his subordinates cannot with the same machinery produce the results that he obtained. He also forgets that the times have changed and that keen competition requires that his cost records should clearly show him how every penny is expended. In his day in the shops there were no elaborate cost systems, and he can see no need for such systems now. He has been progressive in keeping his plant supplied with uptodate with his cost system; this is not he sees the benefits to be derived from modern plant equipment. He is out of date with his cost system: this is not his line and he cannot see the benefits to be obtained. He cannot realize that one is fully as important as the other.

Sometimes a manager erroneously believes himself to be progressive regarding his cost records. He has read something on cost keeping and has heard a discussion of the importance of the subject at the last meeting of this technical society. He decides that he will improve his methods and directs his secretary or bookkeeper to put in a modern system. The latter has made no special study of the subject, and after getting the information that he can obtain from nearby plants and securing some of their blank forms he makes a number of changes and perhaps secures somewhat better results. Frequently, however, no improvement is made in the accuracy of the results, and the shops are required to make a number of useless reports. The secretary reports progress to the manager, and points out the advantages of his system over that of a nearby competitor. If the manager were trying new methods in the shop he would not be satisfied with general reports. He would see for himself exactly the changes made and the results obtained. He, however, is little interested in accounting and knows but little of cost keeping, and he accepts the statements of his secretary and is satisfied, while in reality little or no improvement has been made.

Some owners and managers who have been impressed with the value of accurate costs, and see the necessity for improvement in their cost systems have employed expert accountants to install a cost system, who have had no shop experience and who have no knowledge of shop methods. This has resulted in a system

entirely unsuited to the business, which has brought endless red tape without producing results.

Cost Keeping versus Accounting

There is a line, faint perhaps, but nevertheless a dividing line, between cost keeping and accounting. Cost keeping is only concerned in placing in the most direct way the cost of every element that goes to make the total cost of the product. These costs should be so recorded that the manager can readily discover all excessive costs, whether they be direct costs or an element of the expense burden. Accounting begins where cost keeping leaves off. The preparation and installation of a cost system is the work of a shop expert who has made a study of the application of simple accounting to shop methods. Scientific shop management and accurate cost keeping are inseparable. Scientific management cannot exist without accurate costs. The methods followed in obtaining good management in the shops are closely interwoven with the methods employed to secure accurate costs. Costs are a means to secure a certain definite end, and the most important function of costs is to aid in securing better management, greater efficiency, and a reduction in the cost of manufacture.

The shop organizer knows exactly the form in which costs will give the greatest aid. He is not interested in costs as costs, but only as a step to secure better results. He knows what is really required and what is useless. He knows whether the routine required to secure certain data will retard the production of work or not. In other words, he has a comprehensive view of the whole subject and is able to reject all that is of no value in securing the end for which he is striving, that is, the greatest efficiency and the lowest production costs.

An expert accountant has no such view of the subject. He does not know what will aid in the reduction of costs and that which will not. He does not know the form in which costs can best be used in producing efficiency. He is only interested in costs as such. He has no knowledge of the actual work and has no interest in it. He will require records which cost much to obtain, which interfere with the operation of the work and which serve no useful purpose in increasing efficiency after they are secured.

An expert on shop management can learn the simple accounting required in a very short time. In fact, he cannot be an expert without this knowledge. An expert accountant cannot learn shop methods and shop conditions in years. An expert shop organizer will not undertake the reorganization and improvement of a plant unless he is allowed to devise and install the cost system. He knows that any attempt to use a cost system which does not dovetail with his shop methods will greatly retard his work in producing greater efficiency. The employment of an expert accountant to devise and install a cost system in a manufacturing and repairing plant is an absurdity. Yet this mistake has been made by many and the results are almost invariably unsatisfactory:

Cost Systems Secret and Not Subject To Criticism

The manufacturer who closes his shop to visitors soon finds himself behind the times. The exchange of ideas and criticism among manufacturers assists in advancement. Some years ago many manufacturers did not welcome visitors, but now a progressive manager welcomes a competitive manager and gives up his time to show him the plant, and both gain by such visits. This condition does not obtain regarding the cost system, and it is very rare for a manager to permit a competitor to examine his cost system, nor does he desire to explain the methods followed. The cost system is, therefore, not subjected to criticism, and managers and owners are ignorant of glaring defects which would be brought to light if secret methods were not employed. It is curious that nearly all managers believe that they have very satisfactory cost systems, and the worst are usually described as "simple and effective."

Less secrecy will bring about the downfall of many cost clerks, but will also improve the accuracy of costs.

Value of Accurate Cost Keeping Frequently Not Realized by Successful Managers

Many successful managers do not know the value of accurate costs. They know the necessity for the total cost to fix the selling price of manufactured articles, but they do not know that well kept costs will point the way for greater efficiency in production and a consequent reduction in costs. The successful manager as he advanced from his tools to foreman and from foreman to superintendent was employed in plants much smaller than the present-day plants. As he advanced in the supervisory positions he had absolute control of every operation. He knew the ability of each man under him. He was quick to see every extravagance, every lost moment of time, every leak, and he was quick to apply corrective measures. It was these qualities that made him manager or owner of the large plant that he now controls.

He expects his subordinates—his department heads—to do as he did. He forgets that the work is more exacting, that the department heads had more subdepartments, more men. He forgets that these department heads frequently have not his ability, and that many extravagances, many leaks will not be remedied. Such a manager should provide the necessary machinery to point the way for improvements, and establish a check on subordinate officials. A well devised accurate cost system is the machinery required.

In the report of the committee of the National Machine Tool Builders' Association the following statement is made: "The day will come when no manufacturer who has a permanent and growing success can have that success without a complete and accurate cost system. And such a system will be as essential in the business of manufacture as a good superintendent and a good organization and good workmen."

Can an Establishment Make Money without a Good Cost System?

The question naturally arises, are not many of the concerns which are without good cost systems making money? Undoubtedly they are, but how often do we see a shop with antiquated machinery making money? Owing to other advantages this is done in spite of the inferior plant equipment. If the same shop had modern tools it would make much more money. The same is true of the cost system. The manufacturer who once gets an accurate cost system will never give it up. He considers it far more important that his best machine tools. The shop that is making money without a cost system is depending almost entirely on the good judgment of its manager and superintendent and *luck*. Oftentimes the manager and superintendent must *guess* what they should *know*. Give these same men the facts that are given by accurate costs—give them an accurate record of what is taking place in the plant, as shown by a proper cost system, and they can apply their judgment to much better effect. Knowledge then takes the place of guesswork.

When cutting pipe threads in a lathe it is very hard sometimes to get the exact diameter necessary. A good machinist is expected to make few or no mistakes but a machinist who is so good that he makes no mistake at all is only fit for pushing clouds.

When a mistake is made and the threads on a six-inch pipe are cut a trifle too small, so that it screws right up to the shoulder, then it stands to the machinist to get out of the trouble the best way he can. A very good way is to use wire cloth, of the brass variety, about 60 or 80 meshes to the inch, similar to that used by the farmer for straining his milk. Wrap a bit of wire cloth around the pipe, daub it with litharge or red lead and screw the pipe home with the wire cloth in the joint. This joint will never leak or come loose. If even more permanency be desired, daub the wire cloth with Smooth-on; and rest assured the joint will never come apart until the fitting is broken off.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

Facing Tool for Distributing Valve

Accompanying drawing shows our method of reducing the shoulder and cutting the clearance on application valve seat for distributing valve, *E-T* equipment.

When these valves come in for repairs there is always a shoulder worn at the end of valve travel, and as the seat is 6 inches long by 1 inch wide, and travel of the valve only 7 inches, this shoulder, or high spot is 3½ inches long. Formerly this had to be filed and scraped, which was a slow and expensive operation.

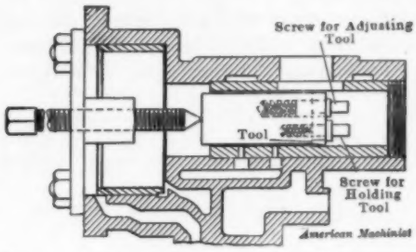


FIG. 1. APPLICATION OF FACING TOOL FOR DISTRIBUTING VALVE

To operate the tool shown, insert in bushing, round plug which has tool holder in end and eccentric screw to adjust the tool in cut. When the tool is set, it is forced through bushing by the screw, as shown. This tool will take 1/32-inch cut, so that one operation with it is all that is required. After this seat is reduced 1/32 inch for clearance, all that is required is to face the remaining flat seat, which is only 2 inches long and can be quickly done.

This tool makes a saving of two hours time in facing this seat. Drawing gives full details, which will be plainly understood by those wishing to make one.

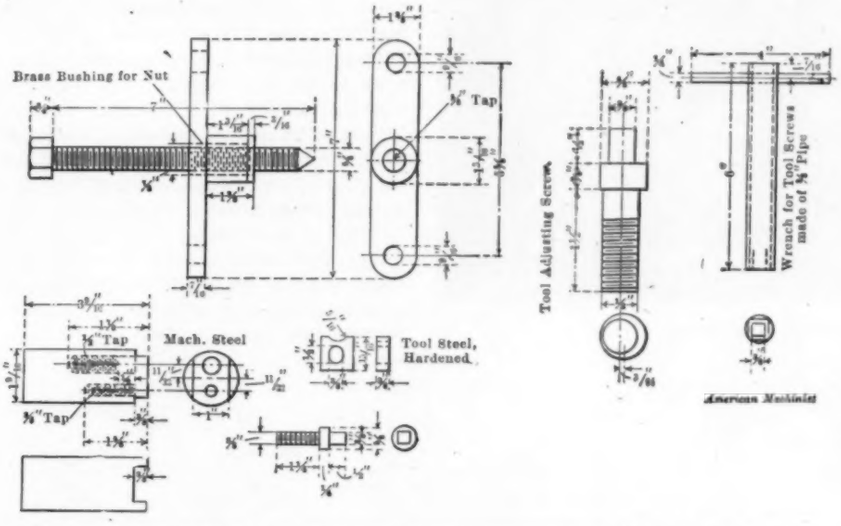


FIG. 2. DETAILS OF FACING TOOL FOR DISTRIBUTING VALVE E-T EQUIPMENT

Wm. Devine, one of our machinists, deserves credit for this tool.

CLINTON, IA. CHARLES MARKEL.
Shop foreman, C. & N. W. Ry.

American Machinist Dissected for Shop Circulation

A new scheme for utilizing the full value of the practical and technical articles now appearing in the weekly edition of the AMERICAN MACHINIST has come to the writer's notice, and as this should prove of considerable value to every shop organization in the machinery business, I conclude to put it before your readers for their consideration.

Upon receipt of the paper each week, it is carefully gone over, preferably by the manager, if that official has the time, and each article upon a subject which appears to have valuable bearing upon the work done by the shop in question, is marked in blue pencil. The paper is then passed to a clerk whose duty it is to cut out the marked articles carefully and paste them upon separate sheets of cardboard, the latter being numbered to properly identify them for permanent filing and indexing later on.

These cardboards containing the articles are then returned to the official who marked the articles, and he notes upon the back of the card the name of the shop employees to whom they are to go. After they have been circulated among those whose names appear on the back for careful perusal, the cards are returned to the office, where they are filed in a suitably sized cabinet and indexed under subject, the cards being numbered consecutively to aid in quickly locating them for reference when occasion requires it.

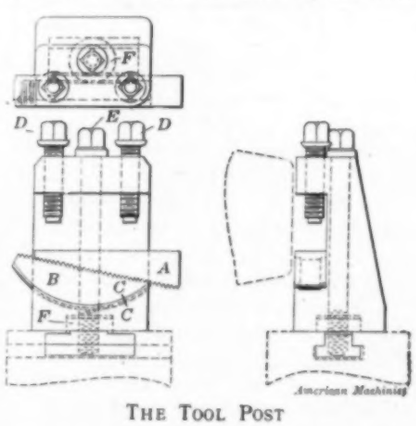
The size of the cardboard is preferably 6x8. The scheme has a distinct educational advantage, and in many cases will prove its value in dollars and cents.

New London, Conn. S. RUSSEL.

A Tool Post

The screw-machine tool post here shown does away with most of the annoyances usually met with in setting up the machine.

The tool is roughly centered by the adjustable tool seat *A*, on the rocker *B*, using the mark *C C* as a guide to keep the tool parallel. The finer adjustment of the tool is then obtained by the tool-clamping screws *D D*. The tool post, with the tool firmly held, can then be clamped in any desired position on the cross slide with the screw *E*. The bottom



THE TOOL POST

of the tool post is chambered to take a round boss *F* on nut in the T-slot and this boss permits the tool post to be set at any desired angle.

If the tool seat *A* should require too much adjustment so that it will interfere with the work, the tool seat and rocker can easily be reversed.

C. G. SWALLENDER.

Jamestown, N. Y.

A Convenient Flue Cutter

Inclosed you will find a photograph and detail sketch of a device for cutting out flues from a locomotive boiler. The tool holder is first inserted in the flue, the cutting tool is placed in the holder and the point is driven through the tube.

The socket *A* is then attached to the tool holder at *A*, the 1⅛-inch steel rod with a square on one end to fit the spindle *Y*, and an eye on the other end which is welded into socket *A* at *B*. This rod drives the cutter to be inserted into any flue without changing the device. One revolution cuts off the flue.

The halftone shows clearly the assembled device and the method of hanging it up with a block and fall. The two chains shown on the lower part of the device are very important. These chains are anchored to each frame to steady the device and keep it from swinging around when cutting off a flue. The large gear wheel is mounted on the spindle *Y*, which drives the cutter, and the power of the motor is transmitted through the gears *V* and *W*. The ease with which this device can be adjusted from one flue to another is a feature that should recommend it to anyone.

Stroudsburg, Penn. W. H. SNYDER.

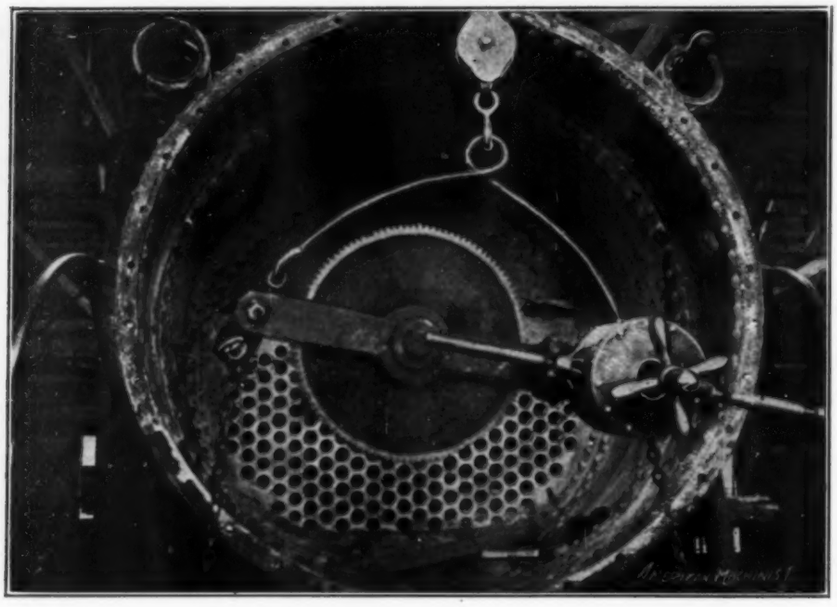


FIG. 1. A CONVENIENT FLUE CUTTER

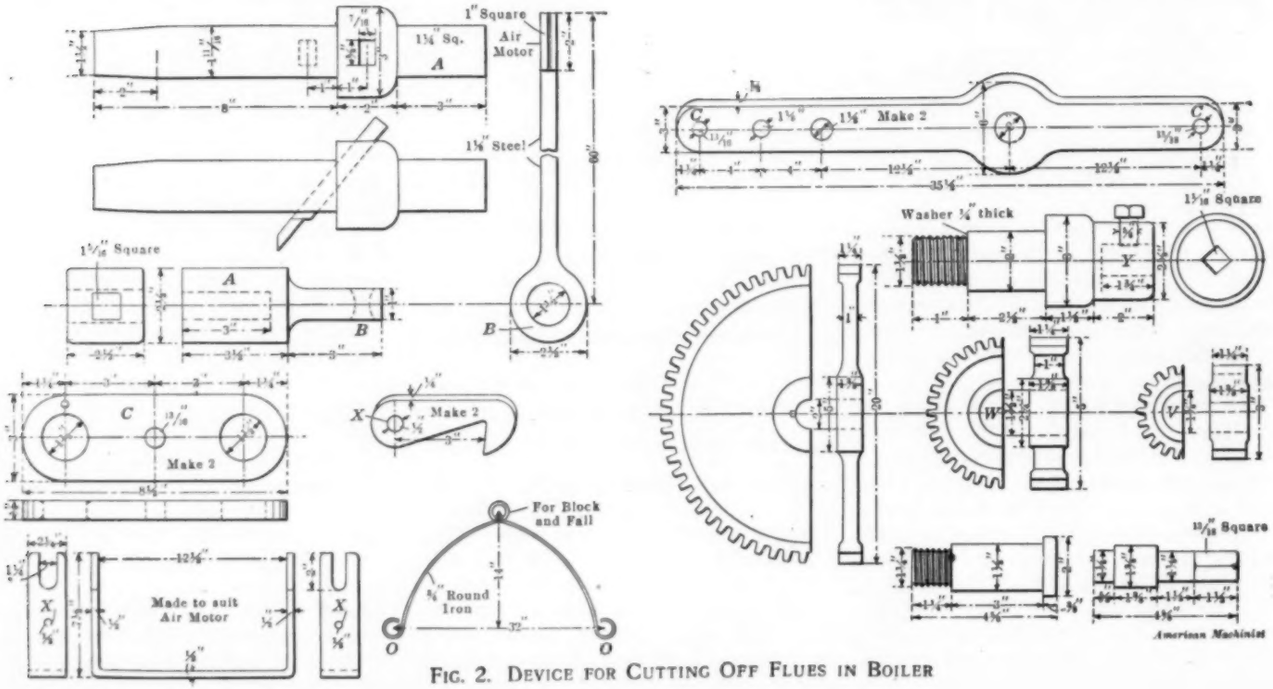


FIG. 2. DEVICE FOR CUTTING OFF FLUES IN BOILER

Pencil Sharpener and Pointer

Keeping a sharp point on the pencil plays an important part in the draftsman's everyday work; pencils usually being sharpened with a knife and the lead pointed on a file, or piece of sandpaper. I have made and been using what I term

PENCIL SHARPENER AND POINTER

a "file chisel," with which the sharpening and pointing can both be done.

This tool is as shown in the cut, and very easily made by anyone. It is nothing more than a 4-inch, hand, second-cut file with the end ground to a sharp edge; mine being hollow ground and the bevel running back about 5/16 inch. This allows it to be readily rubbed up on an oil stone when a little dull. I have used this file chisel for nearly a year, and rubbed it up only about four or five times.

After a few trials this tool will be found very useful and will do away with the dirtying of the hands, as usually happens in sharpening a pencil with a knife.

Philadelphia, Penn. FRANK J. SEPAS.

A Homemade Machine for Grinding in Taper Plug Cocks

Fig. 1 shows a machine which recently came under my notice for doing this class of work. It can be used either to give a continuous rotary motion, or an oscillating one, at will, and seems to give good results.

Fig. 2 is an end view of the headstock, which is fitted on a gray-iron bed *A*. *B* is a casting very similar to a back-geared engine lathe headstock, with a boss in the center as shown. *C* is a solid spindle, and *D* the driving pinion with a sleeve and dog clutch on as shown. The grub screw shown is sunk into a segment which runs in a groove sunk in *C* and keeps *D* in position on the spindle. There are, of course, two of these screws and segments. *E* is a gray-iron toothed sector or quadrant, pivoted on a shaft which takes the place of the back gear, and meshes with *D*. *F* is a pulley which runs loose on the spindle *C*, in exactly the same way as the pinion *D* does. *G* is a steel sliding clutch, which slides on two feathers sunk in *C*, and is operated by the handle *H*, and a forked lever, which is keyed on the shaft *I*. *J* is a connecting rod, which couples the sector *E* to the faceplate *K*, which is keyed on the end of the overhead shaft as shown, marked *L*. *M* is the driving pulley which takes the place of the cone pulley, and *N*, *O* are the fast and loose pulleys for the countershaft belt. *P* are the two bearings.

It will thus be seen that when the countershaft is running, the pulley *F* will be revolving, and the pinion *D* making an oscillating movement. By operating the handle *H*, the workman can produce either a continuous rotary motion at the work *S*, or an oscillating one, at will. This machine has been in use some years, and is giving entire satisfaction.

B. F. Arnold.

Manchester, England.

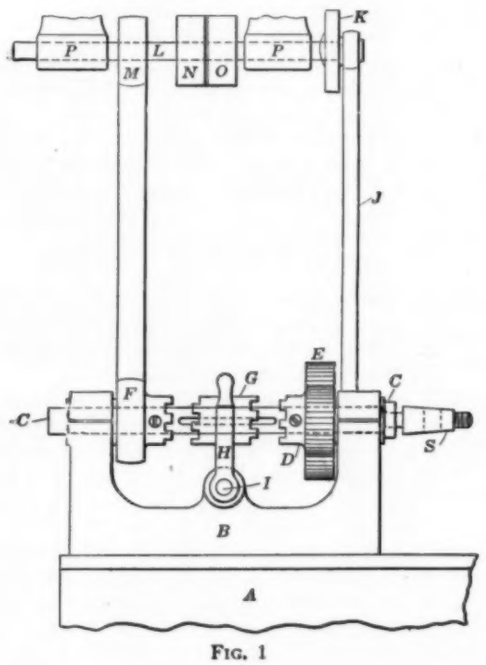


Fig. 1

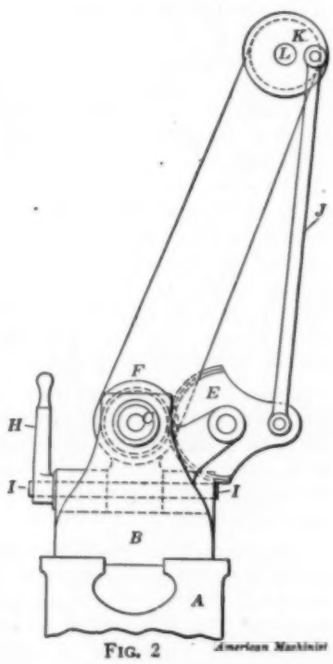
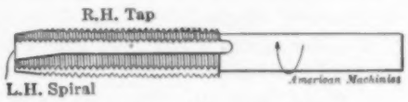


Fig. 2

A Machine for Grinding Cocks

A Tapping Kink

The sketch shows a kink in tap making that has helped me out many times. At times, while working on a hand screw machine, I have had trouble with the tap breaking when tapping through holes, especially when the stock being worked was of tough nature. By filing away the cutting faces of the tap, as shown and giving it a spiral of opposite hand to



A Tap for the Screw Machine

that of the thread, the breaking has been overcome. Cut this way, I have had the tap force the chips ahead of itself, thus preventing the chips from clogging.

Cutting a tap in this manner will also help if the stock is hard.

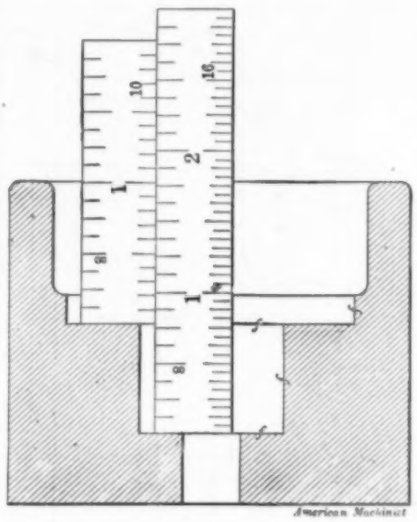
Springfield, Mass. A. L. Fay.

Two Scales as a Depth Gage

A little kink that may prove of interest to some of your readers is the use of two scales, for measuring accurately in the manner shown in the accompanying sketch.

There are often conditions which prevent the use of such instruments as the depth gage or the micrometer caliper, until the work is taken from the machine, then the plain steel scale is the only thing to use and when applied as shown, with the aid of a magnifying glass, a variation of 0.001 inch can be detected.

The sketch shows an axial section through a piece being bored in a lathe and illustrates a condition where it would be difficult to measure the distance between the finished faces in any other way. The depth from one finished face to the other is readily read on that portion of the scales extending beyond the outer



Two Scales as a Depth Gage

edge. There are many conditions which seem to force the adoption of this method, and an example of how decimal parts of an inch may be read directly may add to the value of this article. In the sketch, the scales read 0.775 as the depth, because the 1/10 graduation on the 1/10 scale comes in line with the 7/8 or 0.875 graduation on the 1/8 scale; or to carry out the idea of reading beyond the edge of the piece the 1.10 line comes in line with the 1.875 graduation, giving a reading of 1.875—1.110 or 0.775 inch. To read 0.775 ordinarily a scale graduated to 1/100 would be used and the mid distance between 0.770 and 0.780 judged with the eye.

Should one wish to read any decimal part of an inch that is a multiple of 0.025 (as 0.225, 0.350, 0.275, etc.) the 1/10 and 1/8 scales will be adequate. Select the next larger figure on the 1/8 scale having the same digits in the 0.01 and 0.001 column as the desired reading. 0.825 being the desired reading, 1.125 would be selected, then subtracting the desired figure 0.825 from the selected figure 1.125, we have 0.30, the graduation on the 1/10 scale that must be brought in line with the graduation 1.125 se-

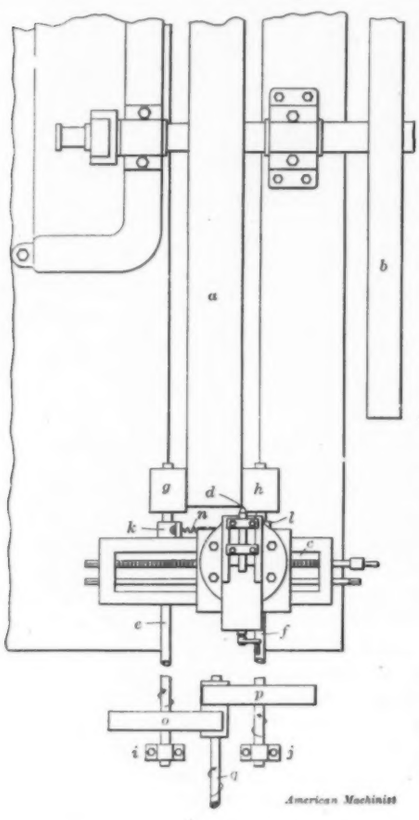
lected on the ⅛ scale. In short we subtract 0.30 from 1.125 to measure 0.825. By the use of one scale graduated to ⅛ inch and another to 1/50 (or 0.020) any multiple of 0.005 inch can be read directly by figuring in much the same way.

HARRY C. YAEGER.

Middletown, Conn.

Turning a Flywheel in Its Own Bearings

The flywheel in question was about 10 feet in diameter and belonged to an engine which had been in use 40 years. The flywheel had not been turned originally. The engine drove the line shaft through spur gearing. Owing to an accident the gearing was broken, and to get a new one with pinion meant a delay of 10 days at least. It was decided to turn the flywheel and drive by belt. The difficult problem was to turn the 10-foot flywheel. Our largest lathe would only take six feet diameter, and if it was packed up would probably chatter badly. No boring mill was in the town, and the flywheel would probably be difficult to remove from the crank shaft. We then thought about turning it in position and after thinking the matter over, we managed the job in this way:



TURNING A FLYWHEEL IN PLACE

The pump which fed the boiler was of the old-fashioned type, with the steam cylinder at the top, the water cylinder at the bottom and the flywheel between. The crank shaft of the pump was at right angles to the engine crank shaft and about six feet below it. We decided to make this pump drive the engine flywheel slowly enough for turning it in its position. The cut shows a plan of the arrange with the gearing, tool, etc., in position.

The flywheel to be turned is shown at *a*, *b* being the spur wheel which was broken; *c* is the cross slide of a planing machine, which was laid on some planks (not shown in the drawings) and securely wedged with planks from the roof and walls; *d* is the tool, which was an ordinary lathe tool; *e* and *f* are two shafts with hard-wood drums *g* and *h*, secured to each shaft; these drums, being one on each side of the flywheel, turned the flywheel by friction.

The two shafts *e* and *f* were mounted in fixed bearings *i* and *j* at the outer end and at the inner end they were in loose bearings *k* and *l*. A bolt connected them together at the bottom, and a strong spiral spring *n* at the top. As the nut on the bolt was screwed up the tension on the spring *n* would increase till there was sufficient pressure between the hard-wood drums *g* and *h* to turn the flywheel. The two shafts *e* and *f* were turned by the two pulleys *o* and *p*, which were driven by belt from the bottom shaft *q*, which was coupled up with the pump shaft. The two bearings *k* and *l* were prevented from lifting by an eye bolt (not shown in drawings). The tool was fed across the flywheel by hand, a chalk mark being put on the flywheel and the handle moved so far each time the chalk mark passed the tool.

The flywheel was about ¼ in. out of truth, so we had to take two cuts. We did not bother about turning it any particular size, as we knew we could adjust the governor of the engine a little to get the line shaft going at the same speed as before.

Of course, the pump had no governor to it, so a man had to keep near the throttle valve in case it "raced." When the rim of the flywheel was turned we did not trouble to turn the sides, but left them as they were. A file was then fastened in the tool box and fed slowly across, which put on a decent finish.

We had the whole job done in under two days. Though a fairly decent cut was taken with the tool, no chatter was felt; this, I think, was owing to the wood driving blocks giving a positive pull down close to the tool.

The wood blocks were made from sycamore and did not wear very much in the time. The two bearings *k* and *l* were fitted with Stauffer lubricators which were screwed up every few minutes, so no heating was felt here. The tool was made from Armstrong-Whitworth steel and the cutting speed varied from 25 to 35 feet per minute.

This flywheel has now been working about three years and the alterations have cost nothing for repairs; no noise is heard in the engine room, only the swish of the belts, though with the spur-wheel drive the noise was deafening.

Lancashire, Eng. ARTHUR JACQUES.

Gage for Locomotive Tires

The Canadian Pacific Railway Company experienced considerable difficulty in measuring the depth of wear in their locomotive driving tires and tender tires. To overcome this an aluminum gage of the design shown in Fig. 1 was made.

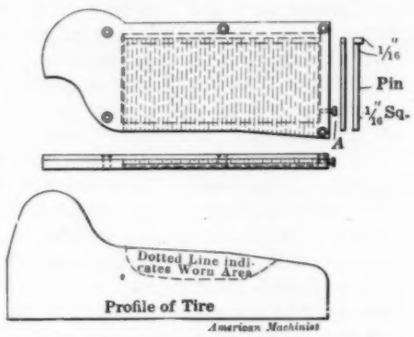


FIG. 1. ALUMINUM TIRE GAGE

The gage is cast aluminum and the necessary finishing is done with a file. The pins are of the same material and are a sliding fit on one another.

When the gage is placed on the tire the pins fall into the hole or worn profile.

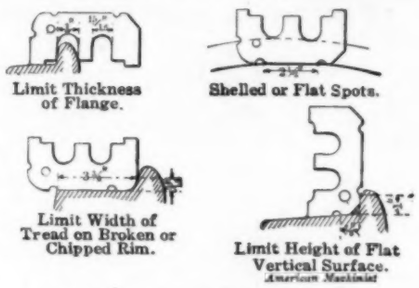

Limit Thickness of Flange.
Shelled or Flat Spots.
Limit Width of Tread on Broken or Chipped Rim.
Limit Height of Flat Vertical Surface.
American Machinist

FIG. 2. USE OF M. C. B. GAGE

The clamping screw at *A* is tightened, the gage removed and measurements taken.

Fig. 2 illustrates the use of the Master Car Builders' defect gage.

The Canadian Pacific rules for the use of this gage are: When worn or shelled-out spots are over 2½ inches long (or so numerous as to endager the safety of the wheel) the wheel or tire must be taken out of service.

The flanges of wheels with journals 3¼ and 4¼ inches in diameter must not be so worn that the flat vertical surface is greater than 1 inch and those with journals 5 and 5½ inches in diameter must not be over ⅞ inch high.

Wheels of cast iron with journals 3¼

and 4¼ inches in diameter must not have flanges 15/16 inch or less in thickness, and in those with journals 5 and 5½ inches in diameter the thickness of the flange must not be 1 inch or less.

Wheels must not have chipped flanges when the chip exceeds 1½x½ inch wide, or if it extends ⅛ inch past the center of the flange, or if the flange is broken.

The rim of the wheel or the tire must not be broken or chipped if the tread measured from the flange at a point ⅝ inch above the tread is less than 3¾ inches wide. There are numerous other rules but these are the most important in connection with this gage.

A C. P. R. APPRENTICE.

A Toolmakers' Indicator

Many good indicators have been shown in the AMERICAN MACHINIST and some can be had in the market, but I have not been satisfied with any of them for general work, that is why I made the one shown herewith, which I have used and found to be the best for general work. Let us hope that someone will be disatisfied with this and show us one in the columns of the AMERICAN MACHINIST that is better.

A is the body, which is made of ¾-inch cold-rolled steel. The scale is soldered in place at the top. At the bottom are the two bosses, which are also soldered in place. A pointed set screw is used in each for the indicating arrow to pivot on, a very light flat spring on *B* forms the tension. *C*, in which the pin *G* is a neat sliding fit, is pushed on the body *A*.

D and *E* are washers which slide on screw *H*, which is soldered to body *A*. *F* is a nut which is used to clamp the indicator in any desired position. For internal work and many other difficult positions *J* is used, which has a tapered hole corresponding to the taper on the outside of *C* on which it is forced. In the arm which extends from the bottom of *J* the right-angle piece with a ball on one end swings on a pin. This right-angle piece is held in position by a very small flat spring which rests on top of the center boss.

When *J* is on *C* the straight end of the right-angle piece rests on the pin *G;* this serves to move the indicator.

For *measuring*, this indicator is not very accurate, but for indicating, I never had one to equal it.

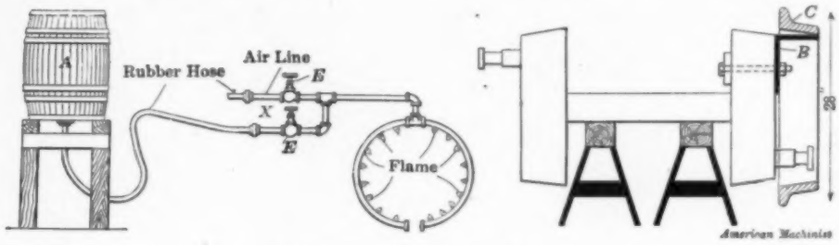
CHARLES SEHL.

Philadelphia, Penn.

Gasolene Torch for Heating Locomotive Tires

The cut shows a rig for heating locomotive tires evenly for shrinking. Recently our repair shop had a locomotive on which four tires had to be shrunk in a hurry. We allowed 1/32 inch for shrinking.

A is a half-barrel of gasolene, elevated on a couple of horses. To the bottom of this barrel, a hose having been connected, we ran the gasolene through a pipe into a pipe *D*, curved the shape of the outside of the tire to be heated. This fixture, being built of light material, a man could stand between the pipe at *X* and hold the heating pipe around the tire *C*. The air and gasolene are controlled at will by the two globe valves *E E*. The curved heating pipe *D* is perforated with 3/16-inch holes about five inches apart for the flame. A tire *C* is shown ready to be pushed on when expanded sufficiently. The tire is hung on a piece of angle iron *B*, bolted to the side of wheel.



THE TORCH AND THE WORK

ROBERT FULLERTON, JR.

Woodbridge, N. J.

A Makeshift Taper Attachment

Having a lot of rivet and bur sets to taper, and as the rivet sets have cupped ends for forming the heads, they had to be turned in the chuck. I made and attached to one of the lathes the attachment shown in the cut.

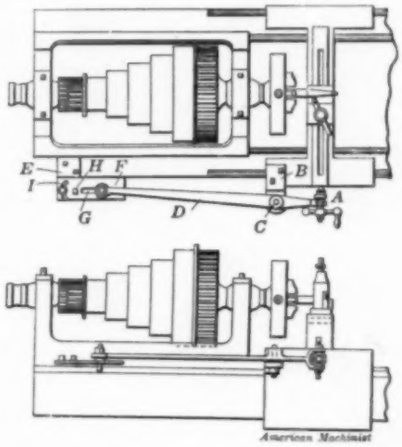
I unscrewed the bearing nut *A* from the saddle and drilled holes in opposite sides to receive pointed screws. I then fitted to the end of the saddle a bracket *B* with stud *C* on which the lever *D* swings.

I then fitted a bracket *E* on the end of the lathe bed. On bracket *E* is a plate *F*, with a slot *G*, pivoted at *H*, with a circular slot *J* to swing the plate *F* for the required taper.

The lever *D* is forked at one end and has set screws inserted fitting the holes drilled in the nut *A*. The opposite end is fitted with a stud and roll, the roll working in the slot *G* in the plate *F*.

As the carriage feeds from the chuck, the plate *F*, being set so that the roll moves in the slot *G*, the end carrying the roll will be carried away from the lathe bed, thus forcing the other end which is attached to the nut *A*, which carries the tool-post screw, in toward the center.

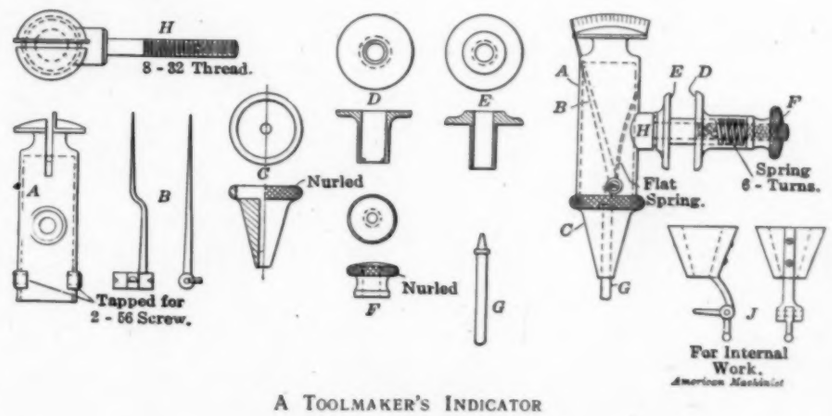
The amount the plate *F* is swiveled on the bracket, governs the taper turned.



THE TAPER ATTACHMENT

ARTHUR C. GOODWIN.

Kennebunk, Me.



A TOOLMAKER'S INDICATOR

Discussion of Previous Question

Design of Ball Thrust Bearings

In the AMERICAN MACHINIST on page 1057, Part 1, Volume 33, appears an article by Henry Hess, in which he makes the statement that "ball bearings do not start out with a heavy load on one side and a light one on the other." The fallacy of this statement, whether it relates to thrust bearings or to radial bearings, is apparent of itself, and is furthermore proved by Mr. Hess' own arguments and diagrams. It is a matter of some difficulty to mount a ball-thrust bearing of the type in question in such manner that the two ball races are exactly parallel, or so that opposite sides of the bearing shall receive equal shares of the load, when applied.

Mr. Hess contends that the difficulty is entirely obviated by making one of the races spherical, without regard to the size of the radius to which the race is curved. He states in relation to his Fig. 5 that, "it is clear that the parallelism between the races is maintained." The essential features of his Figs. 5 and 6 are here reproduced, and the question is asked: If the spherical race is placed obliquely on its support before the load is applied, why should it slide automatically into parallelism with the other race? It must be evident that the friction between the spherical race and its support will tend to retain it in its original position, and whether it will slide or not slide depends upon the relation between R, L and the value of the friction coefficient between the said race and its support.

It was shown in my previous article, page 651, Volume 33, Part 1, to which Mr. Hess refers, that this device can never accomplish an *equal* load on both sides of the bearing. The equations in the said article also show clearly that the greater the value of R relatively to L, the less is the tendency of the race to slide, and if R is greater than the ratio between L and the friction coefficient, the face will not slide at all from its original oblique position, the whole load remaining then on one side of the bearing. As to the conditions under which the device may give *approximately* equal load on both sides of the bearing, it is evident that such conditions may obtain if R is small relatively to L. If the shaft does not extend through the spherical race, this could be arranged for instance, like Fig. 2.

With reference to Mr. Hess' statement that the diagram on page 651 involves contact between the shaft and the spherical race, it is evident that there is no foundation for his statement. The equations, with which he found no fault, do not contain any expression of the forces which would arise if such contact existed.

The subject is of some practical importance, especially in bearings for high speed and great load. The ratio of R to L in the spherical race, is frequently made much greater than necessary, and such races are often found worn deeper on one side than on the other.

GUSTAF RENNERFELT.

Södertelge, Sweden.

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

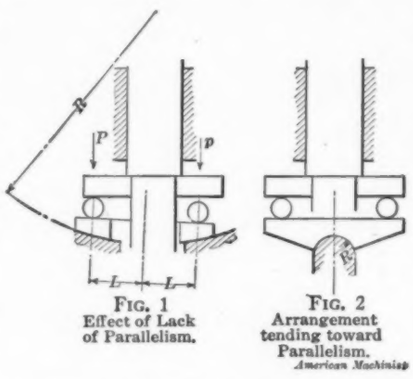


FIG. 1 Effect of Lack of Parallelism.

FIG. 2 Arrangement tending toward Parallelism. *American Machinist*

Preventing Scale in Hardening

My article on page 648, "Preventing Scale in Hardening," does not read as I intended to have it. The proper meaning is this: "When an open flame is used in tempering and the air partly turned off so as to reduce the heat of the flame (the flame in this condition is a reducing flame) and if the work is held in it, it may be heated way above the proper tempering heat without the show of color, for the oxygen of the air is consumed by the flame before it can come in contact with the metal. Now, if the metal is removed to the air, the oxygen strikes the heated surface and the colors flash over it so rapidly that it cannot be quenched at the proper color, or if it is, the heat has been too high and the work is spoiled."

Madison, Wis. H. M.

Card System for Shop and Storeroom

I read with great interest the article under the above heading by C. T. Schaefer on page 356. This was more interesting to me because I have had the task of remodeling card systems in more than one shop. I would have been pleased to see the cards or methods Mr. Schaefer uses in obtaining his patterns and castings.

His article commences with the issue of blueprints to tool room, and an order to the works manager. To my mind it is hardly a works manager's duty to plan out operations. We next find the assistant works manager writing out store-room requisitions for material. After this, I certainly agree "the system is somewhat expensive." In the first case, if the shops are too small to carry a man for setting the sequence of operations, then give the work to the chief inspector. This man has to be a thoroughly practical man, and is in a position to say what operations should be performed first, as he must, or should have copies of the blueprints; which the works manager has not, according to Mr. Schaefer's description. In the second, the assistant works manager or general foreman is performing the work of an ordinary clerk.

The next point that is not clear is; how does the inspector get his card? Does he make it out from the operation cards as the work is delivered to his department? If the inspector made out the operation card giving the sequence of operations, his clerk could make out the inspection card at the same time. These cards would then be all in readiness before the work reached the department. Also they would be aware of what work was coming through the shop.

Mr. Schaefer claims that one "can locate any part, and the amount of work done," by his system. Without the above alteration this is not so, as work would have to be partially done before being entered on inspection card. I am assuming this card is the one from which he finds out how the work is progressing. It cannot be the operation card, as these are scattered all over the works. In the example given; viz., 50 cylinders, the issue was in two lots of 25 each. How will the operation card carry along the two lots; say one is at milling and one lot at boring?

When a man is on piece work, what is there to prevent him being paid for spoiled work? On the man's time card (from which the pay roll is made up) there is no provision to show how many are scrap, and what passed. I know an

instance where a similar omission cost a firm many hundreds of dollars, paying for defective and spoiled work, and parts being booked through more than once.

The booking shown on the stores and stock record card is also inaccurate. When the second batch of 25 was received in stores, there should have been a new balance struck. Say the balance was struck on March 12, the book would have read 7; whereas there actually were 32 in stock.

Referring to card shown in Fig. 12, Mr. Schaefer states: "This card will also snow the advantage of the different manufacturing methods, or should different men do the work, as some men are faster than others." To fulfil this claim, the card should show a column for operation, and another for workman's name or number.

With the above suggestions incorporated in the system, I have no doubt it would work successfully. The method of transit of the work for the various operations and to the inspection department, has not been mentioned in the article, although my experience is that it is an important detail. The best method, to my mind, is for the inspector's laborer to do all transit work: gather the time cards from the men, and take the work to his department; when inspected, carry to next operation, and have inspector O. K. the man's time card for what are correct.

The above criticism may appear severe, but apparently small details are what determine the success or failure of any system, and if they are not taken care of, the system becomes a failure; and "somewhat expensive," would not cover the case at all.

Nottingham, England. GEORGE HEY.

Prevention of Scale in Hardening

On page 458 of the AMERICAN MACHINIST, F. Ches, Newark, N. J., under the above heading, states how he prevents scale on his particular class of work by using boracic acid. He says he has to be careful in melting it else it will blow away.

I have used boracic acid for years, and I mix it into a batter with water, then let it dry. This overcomes the trouble of blowing away. It can be used for brazing bicycle frames or other things by painting the joint with wet boracic acid and wherever the acid is the spelter will be sure to run.

To remove the acid after hardening or brazing, immerse the part in warm soda or soapy water for a few minutes, and it all comes off, leaving the job clean.

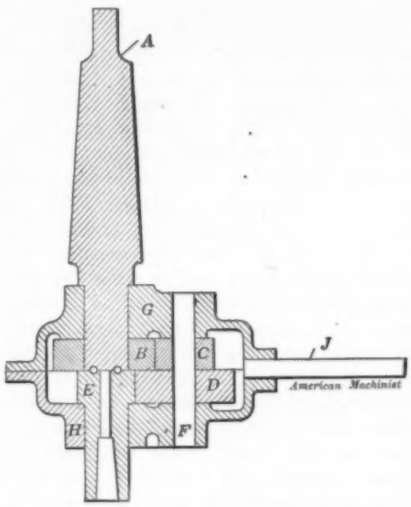
In reply to Mr. Chapman on page 460, will say, that I did not intend to convey the impression that scale could either be formed or prevented in the oil tempering bath, but was criticizing Mr. Haeusser for doing it.

Decatur, Ill. GEORGE F. COLES.

High Speed Attachment for the Radial

On page 573 there is a description of such an attachment. I show another one herewith which is made with spur gears only.

A is the stem, turned on one end to fit the taper of the drill press on which it is to be used, in the middle for a bearing in housing, and on the other end to fit the cast-iron gear *B* which is keyed onto it. The extreme end has a small ball race for a thrust bearing, and, of course, should be hardened. *C* is a small steel pinion, in mesh with *B* and keyed to the



HIGH-SPEED RADIAL-DRILLING ATTACHMENT

shaft *F*. The cast-iron gear *D* is also keyed to *F* and meshes with the small pinion *E*. This pinion *E*, has a ball race, for thrust bearing on the end similar to *A* and is lengthened out for a bearing in the housing and for a taper-drill socket. This latter should be longer than shown in sketch to allow for a drift slot. It will be noticed that the only thrust is directly between *A* and *E* and is taken care of by the thrust bearing without any strain on the balance of the attachment. The speed of this bearing will only be about two-thirds of the speed of the drill, as both *A* and *E* travel in the same direction but at different speeds.

G and *H* are the two halves of the housing, bolted together, and fitted with the necessary brass bushings for the bearing, not shown. The steady arm *J* is clamped between two halves of the housing with a small dowel to keep it in position. The gear ratio for each set, if made seven to four, will give a speed increase of very nearly three to one which Mr. Cawthray thought about right. In this case, however, the drill runs in the right direction.

In case of drills sticking, of course, the handle would tend to fly around, making things interesting for the operator. The arm might be fastened to the drill upright to overcome this, or a hub might be turned on outside of the housing and a friction band placed around it with the proper lever for taking up. In case of trouble, this would slip instead of sending the operator to the hospital.

Milwaukee, Wis. JOHN BAILEY.

Large Radii without Trammels

Fred Horner, on page 360, shows a simple device for the above purpose, which I tried and found to work very well except that the pencil or pen rocked from side to side more or less; due to the wire not being fastened to the center tack. I therefore set about to make up a device of my own, as shown by the accompanying sketch.

It consists of a very few easily made parts. *A* is a pin forced through a thin washer and ground off to a fine point on one end, allowing the other end to project, for the piece *B* to turn on freely. The screw end of *B* is drilled for the insertion of a piece of small diameter music wire *C*. The wire is clamped by the nut *D* and the washer shown, and is made of convenient length. At the end, where the pencil or pen is attached, it is fitted with two small spring rings which hold the pencil or pen tightly. These spring rings are made simply by fastening together the ends of a small music-wire spring, thus forming a circle.

The radius is adjusted by clamping

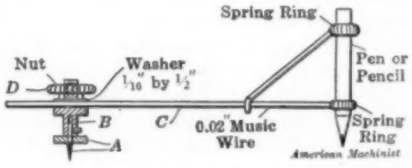


FIG. 1. WIRE BEAM COMPASS

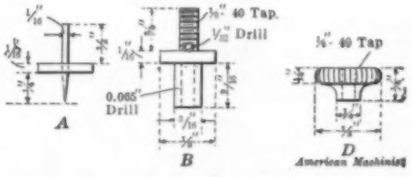


FIG. 2. DETAILS OF WIRE BEAM COMPASS

the nut *D* on the wire at the desired point. The piece *B* revolves on *A*.

This little tool can be made in a few minutes and will do remarkably good work.

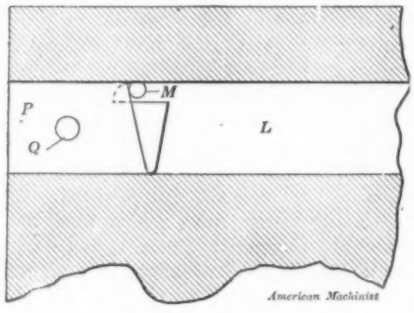
Philadelphia, Penn. J. H. HARRIS.

Making Helical Springs

On page 546, Frank S. Bunker describes a method of winding helical springs, which certainly will give good results, but it seems to me that he does considerable unnecessary work on the spinning blocks for making compression springs.

In the first place, if the spring to be wound is of a small outside diameter, with a comparatively large diameter of wire (say ¼ inch diameter by No. 55 wire), it requires a small hole in the block, which makes it necessary to use a small, springy boring tool, liable to chatter, in cutting the spiral groove, leaving it rough and uneven. Also, referring to his drawings, it would be quite a difficult matter to drill guide hole *M* so as just to line up with the groove. And, again, it is entirely unnecessary to cut the spiral groove on plug *P*, as the wire would follow the groove in the spinning block without any other guide.

A simpler and more economical way, is



SPRING GUIDE WITHOUT GROOVES

to dispense with the grooves entirely, as in the accompanying sketch. The hole *L* can be drilled and reamed in the drill press, thus doing away with the time and bother required to set up the piece in the lathe. If care is taken in reaming, the hole will not require lapping after hardening.

As to the plug *P*, all that is necessary is to file the end of a piece of Stub's wire to a helical form corresponding to the pitch required for the springs and harden. Care must be taken to locate the helical end so as just to come to the edge of hole *M*, with the beginning of the helix far enough below the hole to clear the wire as it passes through. After locating it may be held in place by dowel pin *O*.

As the wire comes in contact with the end of plug *P*, it receives and retains the same set and uniformity as with Mr. Bunker's method, while the time required to make the apparatus is considerably lessened.

Hartford, Conn. C. A. KNOWLES.

Distribution of Load in a Ball Bearing

On page 84 there is an article under the above caption by F. H. Poor. In that Mr. Poor calls attention to the generally used formula for ball bearings, according to which one-fifth of the number of balls are considered as carrying, and criticizes that interpretation as being wrong.

Mr. Poor is both correct and incorrect in his criticism. The illustration that Mr. Poor brings from my paper on "Ball Bearings" before the American Society of Mechanical Engineers does give the correct and actual distribution of load between the various balls on the carrying side of a bearing. Anyone who wishes to determine accurately the division of load can use this diagram and formula.

In practice, however, about 95 per cent. of ball bearings lie within certain relatively small limits as to size variation, and as to number of balls employed. Within those limits no material error will be caused by assuming that the load is actually carried by one-fifth of the total number of balls in a bearing. This 5, as a divisor in the ball-bearing formula, is, therefore, a convenient constant intended to represent the limitations of average practice. It must be borne in mind also, that when this divisor 5 is used, the total number of balls that might be accommodated in a bearing were the balls making actual contact with one another must be considered. Ball bearings now are very rarely made with balls in actual contact, but balls are separated from one another by distance pieces of various designs; this lessens the number of balls. It would, therefore, appear at first sight that the divisor 5 should be changed. As a matter of fact, however, the compensating advantages attending the employment of separators and the structural features of the races coincident are such as to compensate for the lessened number of balls.

Philadelphia, Penn. HENRY HESS.

Sawing Thin Tubing

I should like to express my opinion of an article on page 593.

If J. F. H. had taken the hack-saw blade that he spoiled in cutting off three lengths of ½-inch brass tubing, and annealed it and filed off the teeth, then held it in the vise, taking a sharp cold chisel, he could have cut very fine teeth, then tempered it and put it in the same frame and he would have a good, stiff saw to work with, as a jeweler's saw is not substantial enough for work of that size.

The using of two blades wastes considerable material in cutting a large number of pieces. The fitting up of the two blades would require as much time as the making of the blade that I suggest.

Cleveland, Ohio. F. F. DURANT.

Hardening a Blanking Die

On page 594, Volume 33, Part 2, of the AMERICAN MACHINIST, J. H. B., Middletown, Conn., shows a blanking die with four small holes in close relation to the large piercing hole and tells how to harden the die without having it change its shape to an extent that would make it necessary to throw it away.

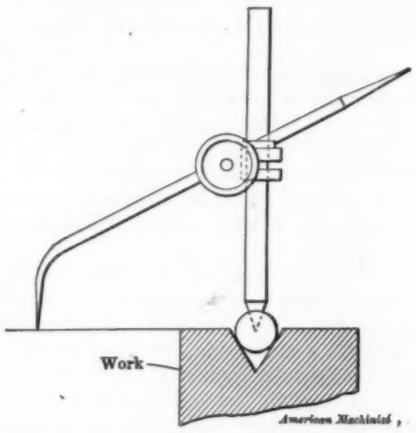
If J. H. B. would make his die of Novo steel, harden it by packing in a mixture of one-half bone black and one-half charcoal, then seal it with fire clay and heat to 1750 degrees Fahrenheit and hold at that heat for a time to be governed by the size of the die, he would not have to use the punch and he would not have even the 0.001 of an inch shrinkage that he speaks of and his die would outlast at least five carbon dies.

A die ½ inch thick should be held two hours after having attained the proper hardening heat and longer as the size increases. The die should be quenched direct from the box and in good oil and the temper not drawn.

Bridgeport, Conn. W. H. WILLIAMS.

Ball Center Dividers

On page 125 is a cone center divider, which was contributed by Arthur F. Kunze. The tool described by him is a handy tool, but I saw a similar device which I think is an improvement. A



THE DIVIDERS

⅜-inch steel ball was annealed and had a 60-degree center made in it. The ball was then magnetized enough to stick on the center bar as shown. The cut shows the ball in place, seated in the center of the work. A ball center of this kind obviates the necessity of having larger cone center bars for larger work.

Washington, D. C. H. D. CHAPMAN.

Hobbing Hindley Worms and Wheels

Cutting Hindley worms and worm wheels in the ordinary shop is a very difficult proposition. Not being equipped with the necessary tools, it often calls for considerable thinking and rigging up to do the work in a satisfactory manner.

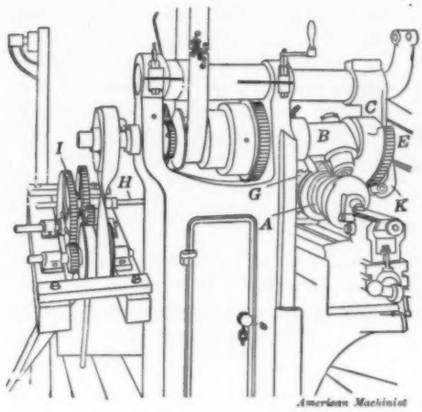


FIG. 1. MILLING A HINDLEY WORM

As I have had considerable experience along this line, I will say that I do not altogether agree with David Brown, on page 913 Volume 33, Part 1. I fail to see how Mr. Brown can cut Hindley worms by the method he described; that is, by inserting cutters in a cutter head and having both spindles and the machine geared so that they run in unison with each other, presumably the same as a hobbing machine.

My opinion is that while cutting Hindley worms the centers of the worm and of the pivot point of the cutter must, at all times, be in the same position as when the worm and wheel are doing the work for which they were intended. In other words, the center of wheel and worm must always be in the same relative positions.

I fail to see how Mr. Brown cuts the Hindley worm with inserted blades in a cutter head, as he explains it, feeding out the cutters in the cutter head. He cannot, by that method, cut the full depth of thread on the worm; therefore, it seems that he must change his center distance, and this will cause the thread to the worm to have steps on the side, the size of which will depend largely upon the amount the cutter is fed per revolution of the cutter head. See Fig. 2. By that method you either will have to have different sets of cutters for each cut, or so arrange the cutters as to feed out the amount required each time the cutter head makes a complete revolution.

The other method described by Mr. Brown; using an end mill, is quite correct, in so far as the principles of the machine are concerned, which I will explain by the accompanying illustrations. By this method I have very satisfactorily milled a large number of double-thread Hindley worms, 1¼-inch pitch, 2½-inch lead, on a No. 3 Cincinnati universal milling machine. Referring to Fig. 1, *A* represents the worm blank; *B* is the regular vertical milling head, as furnished with this miller, which I arranged to swivel on the outer end of the bronze bushing in the front of the machine. The outside end of the vertical milling attachment is fastened to a segment of a 64-tooth wheel *E*, ⅝-inch pitch for double-thread worm, held by bracket *K*, which is supported by the overhanging arm and plate *C*, for holding the milling head *B*. Bolted to the inside of this plate is a bushing, with a hub fitting the hole in the worm-wheel segment, which allows the cutter head to swivel.

Upon the arbor carrying the worm

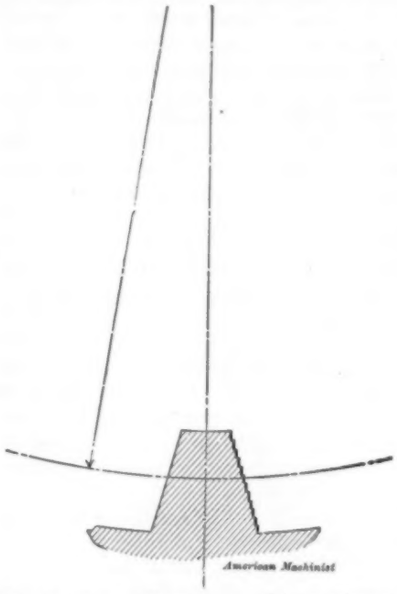


FIG. 2. STEPS FORMED IN WORM TEETH BY ADVANCING CUTTER HEAD

blank there is a gear wheel *G*, meshing with a gear in a bracket bolted to the side of the dividing head, which connects with the worm and worm-wheel segment through a double knuckle joint, giving a ratio of 2 to 1. This gives 2½-inch pitch. On the worm shaft of the dividing head there is a 28-tooth worm wheel connected with a worm 2 inches diameter, ½-inch pitch, which, unfortunately, is not shown in the cut. Shaft *H* is driven by feed gears *I*.

Milling Hindley worms with an end mill may seem a slow process, but it all depends upon the machine tool on which they are cut. In order to obtain good results the parts must be rigid, and there must be some allowance on the ends for thick threads, which must always occur on screws of heavy pitches. The ends are cut off afterward to make the worm the proper length.

Anyone who has had experience in cutting Hindley worms knows that all the threads point toward the center of the worm wheel, and that some of the threads are undercut. I find that this style worm, cut with a 29-degree cutter, does not require any more clearance than an ordinary straight worm.

Now, Mr. Brown says that he has trouble in hobbing a Hindley worm wheel; I cannot see how he can expect anything else. I never attempted to hob a worm wheel of this kind, but I could expect only that the corners should be cut off the teeth in the wheel, as a hob made the same shape as a Hindley worm will not give good results. The hob would be larger on each end than in the center, and when you hob a wheel with a hob of that shape, the hob will cut the teeth in the wheel as they pass in, according to the shape of the large end. Then, as the tooth passes on to the center of the hob, it will change the shape,and when it passes on to the other end of the hob, the shape is again changed. This proves to me that you cannot hob a wheel with this shape of hob.

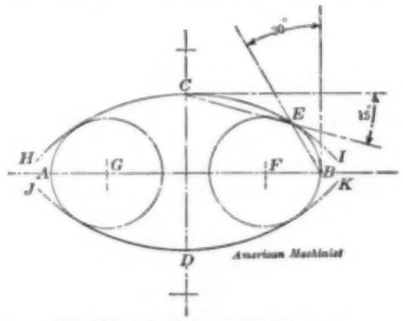
My experience has been that I had to lay out and find the correct shape of the tooth in the worm wheel so it will not have to be hobbed, and then do not gash the teeth but cut them the proper spiral angle for the worm. I have always had good results from this method.

JOHN DUNHAM.

New Brunswick, N. J.

To Draw an Ellipse with the Compass

There have been several contributions lately, dealing with the above subject, but I do not think any of the methods described are superior to the one here illustrated, which is the quickest I have



AN ELLIPSE WITH COMPASSES

yet found, and an ellipse of any proportions can be drawn in this manner.

As an example; to construct an ellipse whose axes are 3 inches and 1¼ inches. Lay off the line *A B*, the major axis; and *C D*, the minor axis. At *B* draw a line 30 degrees from the perpendicular and from *C* draw a line 15 degrees below the horizontal. These lines will meet at *E*. With *EB* as a radius, and centers on *AB*, draw arcs through *A* and *B*. With cen-

ters on *CD*, extended, draws arcs *HI* and *JK*, tangent to the arcs first drawn.

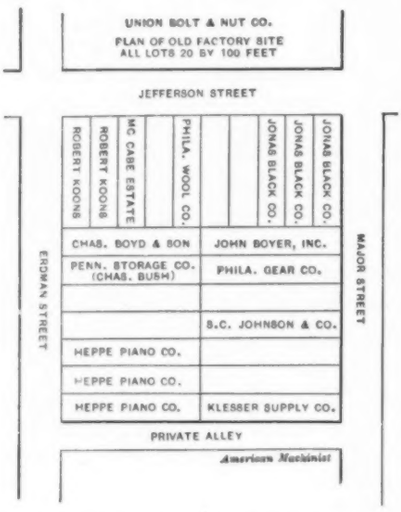
Philadelphia, Penn. T. H. HARRIS.

Blueprinting from Typewritten Copy

J. K. M., on page 597, writing under the above head, advocates the use of a sheet of black carbon paper, laid face up under the sheet to be written upon, and the use of a purple ribbon, as the best means of obtaining blueprints from typewritten copy.

Now I believe I have had about as much experience with this subject as anyone, and I do not consider the method advocated by J. K. M. as being the best, by any means.

There are several objections to this way of doing the work. In order, they are: First, after one or two prints have



EXAMPLE OF TYPEWRITING ON TRACING

been made, the original copy becomes smeared all over with carbon on the back, through handling; after which the blueprints will be blurred. Second; the letters *o, e, a, p*, etc., will nearly always cut a blank from the carbon paper, which will stick fast and completely fill up the loop in the letters, and of course, they will be printed so. It is very hard to pick these little disks of carbon paper from the original; the carbon seems to stick them fast, like glue. Third; if it is necessary to correct a misspelled word, or rub out a letter, it is nearly impossible to do it with the paper in the machine, or if taken out for correction, when replacing the copy the necessary handling will smear it all up. Even without this contingency, the copy is mussed more or less by the paper guard, paper fingers, feed rollers, etc., on the typewriter, which press against the platen.

I would suggest that if the writer in question wishes to use an ordinary correspondence typewriter, and does not want to trouble with changing the ribbon from violet or purple, with which machines are usually supplied, to black for the purpose, he should use on his machine what is known as a "Hectograph" ribbon. This ribbon is no different from those usually supplied, except that the ink is denser. They are made by several firms, and may be procured from any dealer in supplies. I, however, consider the black ribbon best.

He should also be sure to use suitable paper. A good paper to use is a fairly transparent tracing paper, white, with a hard surface, which the type will not cut readily. Eugene Dietzgen Company's "Natural" tracing paper is excellent for this purpose; or any similar paper.

I will endeavor to explain the method in vogue in our office for this purpose. We have in our billing department, an Elliott-Fisher billing machine, which is equipped with gothic type. Many of the readers of this paper are, no doubt, familiar with the construction of this machine. It is made with a flat platen, and the keys strike downward, and permits of the insertion of a sheet of any length. In fact it is possible to write on anything from a postage stamp to an inch board.

We press this machine into service whenever we have any blueprinted typewriting to do. A copy of a specimen of work which we turned out some time ago, accompanies. This is part of a small map, showing property owners in a plot of ground which is being sold off in lots from time to time. Copies of this map are supplied to several different heads of departments, and a new print is issued every little while, as the property is taken up and new names added.

The type, it will be noticed, is different from the ordinary, and being less sharp on the edge, makes a wider imprint on the paper and does not cut it as much as the ordinary type does. We used an ordinary black ribbon on this job, and had great success with it.

One advantage of the flat-platen machine for this work is that the sheet can be kept perfectly flat and is not crumpled at all, as is the case when rolled around the cylindrical platen of the ordinary typewriter, and another advantage is the ease of insertion for writing on any part of the sheet, and at any angle.

The Highway Department of New York, at Albany, has several machines which are used exclusively for this kind or work, and for lettering road maps of several feet length, with a great saving of time and increased neatness over hand lettering.

It seems strange that, with the undoubted savings possible by the use of even the ordinary typewriter for writing bills of material, and work consisting mostly of tabulations and notes, the use of machines for this class of work is not more general; but as the idea is becoming more widely known, it is being adopted more and more, with highly satisfactory results.

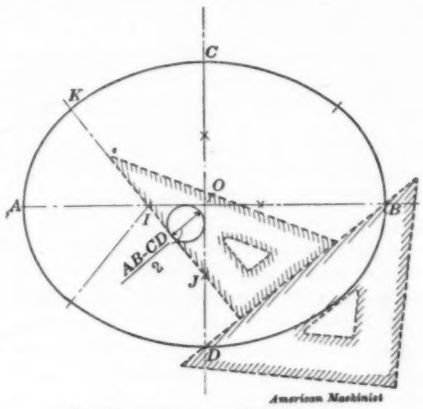
Philadelphia, Penn. T. H. HARRIS.

Laying Out Ellipse with Triangles

On page 648 is described a method of laying out an ellipse, which I reproduce in the illustration, but with a modification added.

The modification has the advantage of requiring no lines to be drawn on the sheet, with the exception of the small part of the circle shown to left and below the center.

The method is as follows: The circle having a diameter $\frac{AB - CD}{2}$, is placed as shown, and enough drawn in to locate the line *JK* tangent to it when the two triangles are arranged as indicated by the



AN ELLIPSE WITH TRIANGLES

dotted lines. The points *I* and *J* are thus determined, and act as centers for the arcs forming the ellipse.

This method seems quicker and simpler, and at the same time requires no extra lines on the sheet, which in some cases, are objectionable.

New York City. F. W. HOWLAND.

Each new belt should be fully treated with some approved form of belt dressing. The old-fashioned dressing, perhaps the best, also the most costly, is neatsfoot oil, but the rules for applying this substance are the same as for applying modern belt dressing, which is to spread a little of the dressing on the belt and let it soak in. Don't put on much at a time; some people smother a belt with dressing, the belt slips and it usually requires two men to keep the belt on the pulleys until the dressing is absorbed. To avoid this, put on a little dressing at a time and do it often. If the belt is new and you wish to stuff it quickly, apply the dressing liberally at night, just at shutting-down time, and the dressing will be absorbed and the belt ready for service in the morning.

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American Machinist

Editorial

Rapid Power Movement of Heavy Machine Parts

Time studies of various operations are very apt to be misleading in some ways. This is largely because they do not often allow for the human element or the machinery going wrong at a critical moment. But they make one point clear admirably—the time lost by not having a rapid power traverse on such parts of almost any machine, as must be frequently moved.

The frequent shifting of milling-machine tables, lathe carriages, boring-mill heads and similar parts becomes very tiresome to a rapid operator and cannot help but slow down his production. We also have reason to believe that this affects his accuracy in two ways. He will make the parts move more easily by loosening the gibs a trifle, and his extra weariness lowers his capacity for accurately reading micrometer graduations.

Just as the crane or light hoist enables a skilled man to turn out more and better work by relieving him of the labor of lifting it, so the rapid power traverse aids him after the piece is on the machine.

Why Is the Diesel Motor a Failure in America?

The Diesel motor, or Diesel oil engine, is not unknown in America, but that is about all that can be said for it. As a general proposition it can be classed as a failure. When we consider the great extent to which it is used in Europe, and particularly in continental Europe, we at once ask the question: Why is it a failure in the United States?

To show the extent of its development on the Continent, the firm of Gebrüder Sulzer, Winterthur, Switzerland, has built upward of 100,000 horsepower of Diesel motors during the last four years. Another firm, at Augsburg, Germany, in a similar period has built upward of 150,000 horsepower. The Aktiengesellschaft St. Georgen is specializing in small sizes of these motors, the smallest of which has a rating of five horsepower.

As new developments, Gebrüder Sulzer are now building for the Prussian railways, a 1400-horsepower locomotive equipped with Diesel motors. At the same time a firm in Nurenberg is building the engines for two 8000-ton freight steamers for the Hamburg-American line, each to be equipped with two 1500-horsepower Diesel engine sets. The Diesel motor, from a standpoint of fuel consumption, is probably the cheapest engine to operate that we know of today.

Facing these facts we are justified in repeating our question: Why is the Diesel motor a failure in the United States? We have an ample supply of liquid fuel and we have a demand for cheap power.

Without attempting to answer the question that we have asked, we will merely point out that the Diesel engine demands the best of workmanship in its construction. The compression of the air in the cylinder is carried up to 33 to 35 atmospheres. The fuel-injection pump works under pressures from 40 to 60 atmospheres, and on the smaller-sized engines the governor must be sensitive enough to divide individual drops of fuel in order to produce the necessary refinement in regulation. The handling of these high pressures, and the demands of governing, require the best of workmanship in the engine parts.

Why Some Managers Fail

The mistake is often made of attempting to accomplish good results with the aid of poor assistants, because of their lower cost on the salary list. Many an able manager has wrecked his career on the rock of mistakes made by low-grade assistants, who were as good as could be had for the price paid.

Boards of directors are all too apt to think that an efficient and well-paid manager can run the works smoothly and successfully with a force of low-paid assistants. They speak of a great general as directing an army of common soldiers to victory, but they quite forget the able captains, lieutenants and even corporals, who have carried out his orders. The most brilliant orders of the best general that ever lived are not worth the paper they are written on unless there are good men to execute them. And the best shop manager is bound to fail if he is forced to employ assistants who are incapable of carrying out his orders properly.

The saving of money in this way is one of the most expensive economies that can be practised, as the manager who cannot depend on his orders being executed, without personally watching every detail, has not time for anything but details; and, to be really successful, he must have time to plan out large and larger developments, instead of details.

Stillman W. Robinson

Professor Stillman William Robinson, educator, inventor and engineer, died at his home in Columbus, Ohio, on Monday, October 31, at the age of 72 years. His rise from the obscurity and poverty of a New England farm to the position of a master of engineering is peculiarly American in character. The story of his early struggles in overcoming difficulties through personal effort should serve as an inspiration to all who read of his life's work, as his enlivened personality served as an inspiration to all who had the privilege of his acquaintance.

He was born in Reading, Vt., March 6, 1838. As a boy he took great interest in mechanical matters, but farm work and the poor educational facilities in a country place gave him but slight opportunity to follow his inclination. He studied and invented in a small way, however, amid these difficulties. When 15 years old his opportunity to give up farming came and his sixteenth year was spent in operating a sawmill and erecting a furniture factory and gristmill. At the end of that year he entered upon a four years' apprenticeship in the machine shop of F. B. Gilman at Springfield, Vt. He studied during this period, meeting his school expenses by occasional jobs at the trade he was learning.

In 1860, with eight dollars and a kit of stencil-cutting tools, Robinson, the youth of 22, started for Ann Arbor, Mich., to attend the State University. He defrayed the expenses of the trip by cutting stencils from town to town, and reached Ann Arbor with $50 in his pocket. During his college career he supported himself by making stethoscopes and graduating thermometer scales. During this period he invented a thermometer-graduating machine. He was graduated from the University in 1863 with the degree of civil engineer.

His first position was assistant engineer for the United States Lake Survey, acting in that capacity from 1863 to 1866. In the latter year he became instructor in mechanical and civil engineering at his *Alma Mater* and from 1867 to1870 he was instructor in mining engineering and geodesy at the same institution. In 1870 he was appointed professor of mechanical engineering and physics at the University of Illinois, thus founding the first school of mechanical engineering in the United States. Here he remained until 1878, during his last year being dean of the college of engineering. From 1878 to 1891 he was professor of mechanical engineering and physics in the Ohio State University, and from 1891 to 1895 professor of mechanical engineering.

In 1895 he resigned to become inventor and consulting mechanical engineer for the Wire Grip Fastener Company and McKay Shoe Machinery Company. In this field, the field of shoe machinery, various inventions yielded him about 40 patents. He was adverse to the use of cams in machine elements and was peculiarly successful in designing link and lever motions. Many of his machines are in use today.

In addition to his other work he was State inspector of railroads and bridges for the State of Ohio from 1880 to 1884, consulting engineer for the Santa Fe railroad from 1887 to 1890, and consulting engineer for the Lick telescope mountings in 1887.

In 1896 the degree of doctor of science was conferred upon him by the Ohio State University, and in 1899 he was elected to the position of professor emeritus in mechanical engineering.

Professor Robinson was a member and past manager of the American Society of Mechanical Engineers, a member of the American Society of Civil Engineers and of the Society of Naval Architects and Marine Engineers; a fellow of the American Association for the Advancement of Science, and member of the Society for the Promotion of Engineering Education. He was author of technical works, among them "Principles of Mechanism" a college text book, besides being a valued contributor to the technical press.

PROF. STILLMAN W. ROBINSON

At the time of his death he was president of the S. W. Robinson & Son Company, of his home city.

In personality he was kind and genial, always ready with helpful suggestions, particularly for the young men around him. His stimulating influence will be recalled with gratitude by many engineers who came in contact with him either as students or in business life.

W. von Pittler

W. von Pittler, the distinguished German inventor, recently died in London, only a few days over 52 years of age. His greatest work was in the design and construction of automatic machinery and machine tools. As long ago as 1879, there was exhibited at the Altona Exposition of Trade and Industry a paper-bag machine, which he, a 19-year old boy, had designed and built and which attracted no little attention. Later Pittler was engaged at Leipsic in the improvement of embroidery machines, which he so thoroughly accomplished that today all such machines contain parts attributable in idea to him. In 1881, four years earlier than Benz and Daimler, Pittler set running in Leipsic his first automobile omnibus, driven by a powder motor of his own device. It was, however, stopped by the police. His most important invention is the Pittler lathe. In his last years he concerned himself with the improvement of hydraulic power transmission with rotating machines.

William C. Ennis

William C. Ennis, who, for nearly 50 years has been connected with the mechanical department of railroading, died at his home in Paterson, N. J., his native city, aged 65 years.

As a boy Mr. Ennis was apprenticed to the machinist's trade in the old Danforth Locomotive Works. Upon the building of the New Jersey Midland railroad he became its master mechanic, serving it and the Susquehanna, for 25 years. He was subsequently master mechanic of the Central New England and Delaware & Hudson; served the American Locomotive Company in various capacities almost from its organization and up to the time of his last illness was active in the proceedings of the New Jersey board of railroad commissioners. He was an honorary member of the American Railway Master Mechanics' Association, and besides his widow and daughter, Mr. Ennis is survived by five sons, all of whom, like himself, have adopted the vocation of engineering, in which four of them have attained prominent positions.

Look Out for These Men

Two impostors, using the names of Holland and Owen, have been attempting to secure photographs of shop interiors and exteriors in Worcester, Mass., in our name.

"T. H. Holland" presented a bogus AMERICAN MACHINIST card and also other cards at various places. He is about 5 feet 8 inches, probably 40 years old, sharp features with a heavy jaw, dark brown hair, a sandy mustache and a slight stoop to the shoulders.

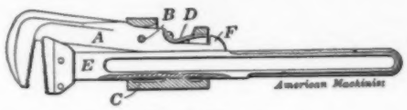
The only men authorized to solicit material for publication in these columns are the members of our editorial staff, who present a *bona-fide* card, or bear a *bona-fide* letter of introduction and authorization.

New Tools and Shop Appliances

A Pipe Wrench

The line cut shows a new pipe wrench which is being put on the market by J. F. Wright, Canton, O.

The jaw *A* pivots on the pin *B* in the yoke *C*, which is held against serrations on the under side of the stationary jaw *E* by the spring *D*. While the pin *B* permits the rocking of the jaw *A* in yoke,



A Pipe Wrench

it does not take any of the strain. This is taken by the lug *F* which is formed on the end of *A* and engages with the yoke.

The tool is a "one-hand" tool and easily operated.

Hamilton Lathe with All Geared Head

The halftones show the headstock of the new Hamilton lathe, built by the Hamilton Machine Tool Company, Hamilton, Ohio. The cut to the right shows the gearing in the head.

The headstock is cast in two parts, the lower section forming a reservoir in which the gears run immersed in oil. The upper section protects them from dirt, etc.

The single driving pulley is of large diameter and wide face. A friction clutch is interposed between the first pair of driving gears, operated by a shifter rod, extending the full length of the lathe, so that the spindle can be stopped instantly from any point along the bed, leaving the pulley running idle. The remaining gears are engaged by shifting those on the spindle to the right or left, as required, by means of the lever at the front of the head, giving in all 12 changes of speeds, six with the back gears in and six with the back gears out, all from a single-speed countershaft. The sliding gears are of steel and changes from speed to speed can be made instantaneously. Motor drive can also be furnished for this lathe.

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.

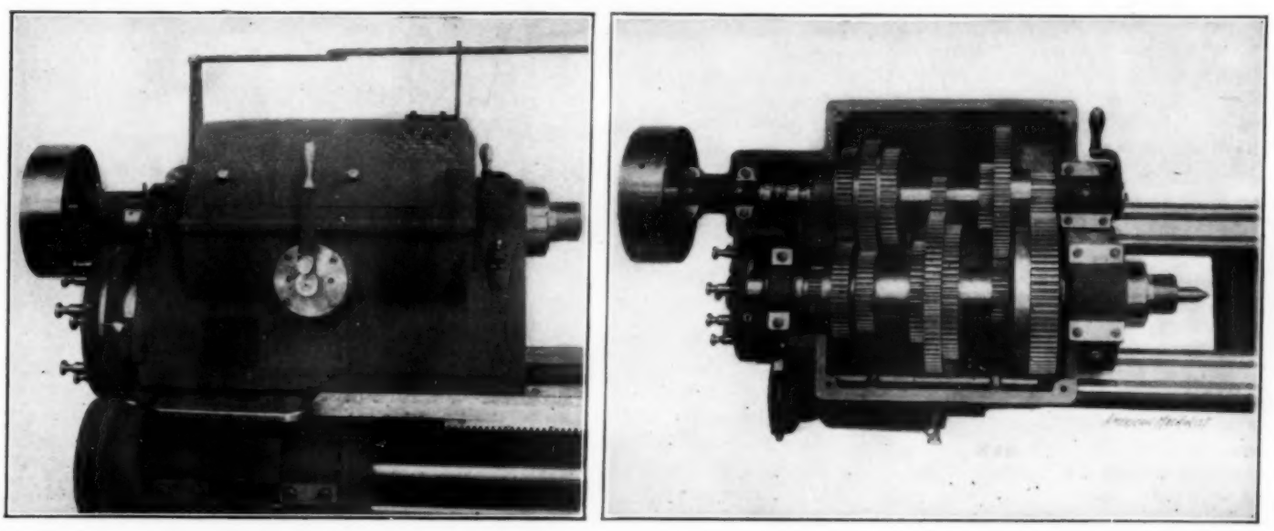
A Wet Tool Grinder

The halftone shows a tool grinder built by Hoysradt & Case, Kingston, N. Y. The

A Wet Tool Grinder

machine is equipped with self-oiling dirt-proof bearings. The countershaft is also squipped with self-oiling bearings which require attention only about every three months.

In this machine the water is contained



Hamilton Lathe with All-gear Head

in the hollowhead and flows automatically to the wheel. The amount of water is controlled by the lever under the pan, no pump being used.

The machine is built in two sizes taking wheels 16 and 24 inches diameter respectively.

A High Speed German Drill

The halftones, Figs. 1 and 2, illustrate a high-speed German drilling machine made by Droop & Rein, Werkzeugmaschinenfabrik und Eisengiesserei, Bielefeld, Germany. Fig. 1 shows this type of machine with a rectangular table, movable in two directions; Fig. 2 shows the machine fitted with a round table and in use.

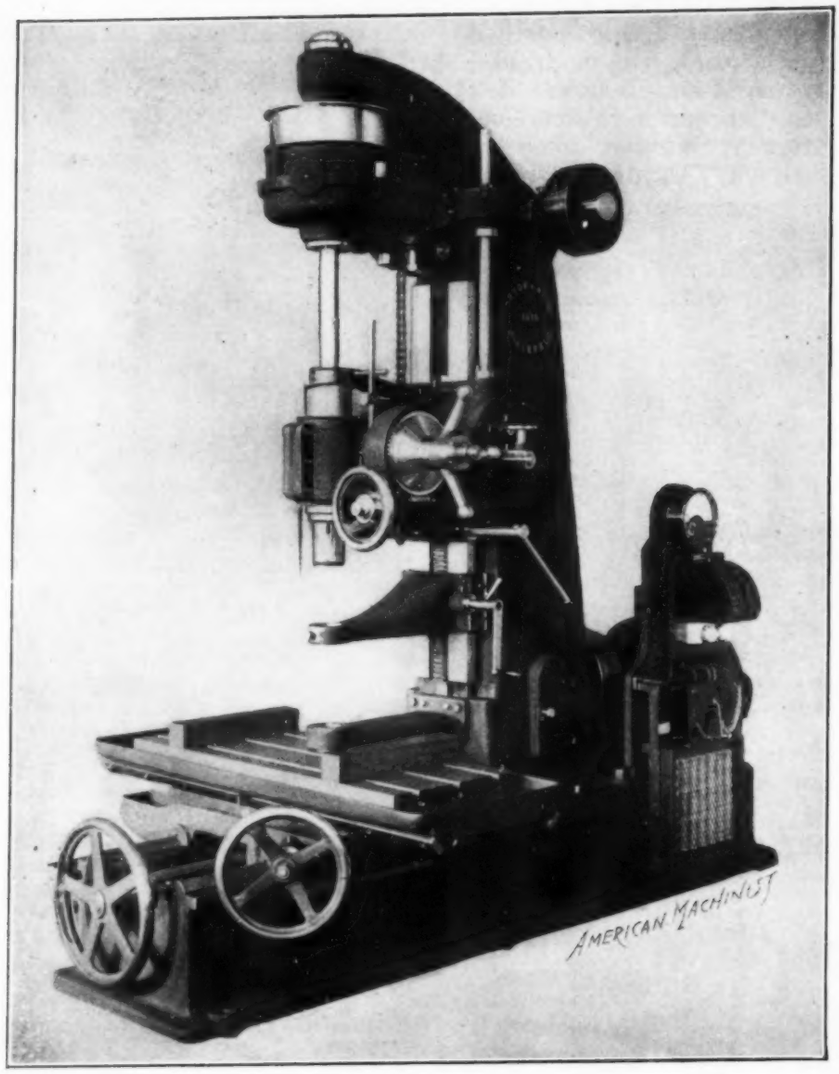


FIG. 1. A GERMAN HIGH-SPEED DRILL

Fig. 1 shows the general design. It consists of a box case, carrying a box-shaped column, supporting at the top the main upper spindle bearing. The driving shaft is behind and just above the bed and is arranged for direct connection to a motor, or to be driven from a countershaft. A belt runs from this main shaft over idlers to the machine spindle. When driven from the countershaft the cone has four steps, thus giving four spindle speeds without the use of any gearing.

The machine is back geared, these gears being placed directly beneath the driving pulley They are entirely incased and are run in an oil bath.

The drill spindle itself is made of nickel steel, hardened and ground and is carried in bronze bearings. The headstock itself, with the mechanism for lowering and raising the spindle, and the hand feed are plainly seen in Fig. 1.

This machine is built in two sizes, given the trade designations 3*A* and 4*A*. The smaller has a spindle diameter of 2¼ inches, and the larger a spindle diameter of 3⅛ inches. The first has a power feed of 9½ inches, and the second of 10¼ inches. The corresponding table

FIG. 2. DRILL FITTED WITH ROUND TABLE

diameters are 27½ inches and 35½ inches. Both machines have eight spindle speeds and eight feeds.

Fig. 3 shows a pair of steel chips, the last cut as the drill was breaking through in finishing out a hole. The shape of these chips, tapering from the maximum width at the larger end to practically nothing at the smaller end, is called attention to as giving an idea of the rigidity of the machine.

FIG. 3. CHIPS CUT AS DRILL BROKE THROUGH THE HOLE

The Hendey Quick Threading Attachment

This attachment is designed for rapid thread cutting, especially on that class of work where the threaded part averages less than three inches in length, although this is not the limit, as the attachment will cut threads up to 6 inches in length. The attachment is very simple in construction, and when not in use is readily disconnected and moved to the end of the bed, where it is out of the way.

The saving in time is accomplished by means of the quick-return sleeve, which returns the carriage to the starting point of the thread, at high speed.

Fig. 1 shows the attachment mounted in position on the lathe with the rocker shaft connected with the bracket on the lathe apron, ready for use. In this illustration the guard over the chasing and reversing sleeves is removed so that they can be seen.

Fig. 2 shows the attachment returned to the end of the bed, where it is out of the way. In this illustration the actuating or rocker shaft is disconnected from the apron bracket and working lever.

The line cuts, Figs. 3 and 4, show the attachment in detail.

The attachment consists of two sleeves, *H* and *V*, Figs. 3 and 4, geared together and rotating at the same speed as the lead screw. Engaging with these sleeves are the nuts *Z* and *Zr*, held in the rocker *Q*. The rocker *Q* is connected with the apron by means of the push shaft *I*, through the handle X in the bracket *W*. The split nut in the apron being thrown out of engagement, rotation of the lead screw will cause the carriage to move

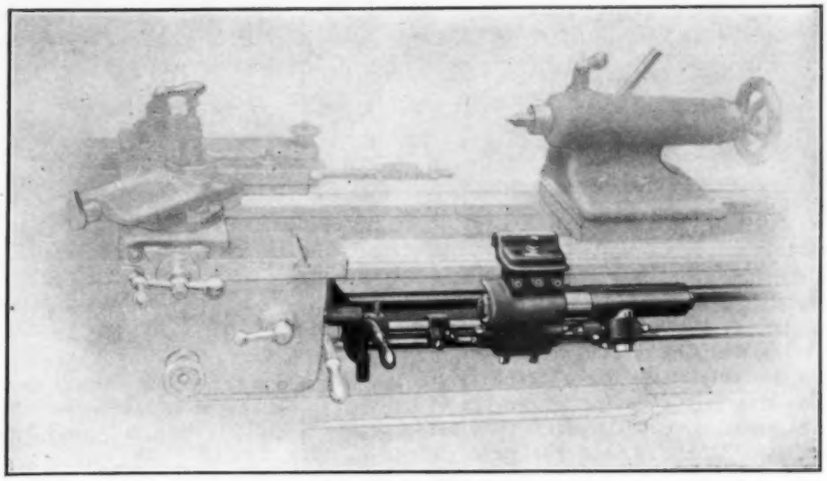


FIG. 1. THE ATTACHMENT READY FOR WORK

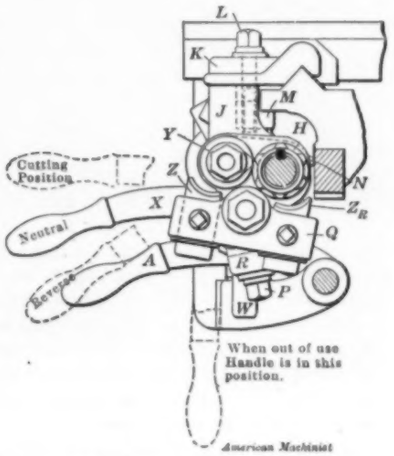


FIG. 4. END ELEVATION OF THE ATTACHMENT

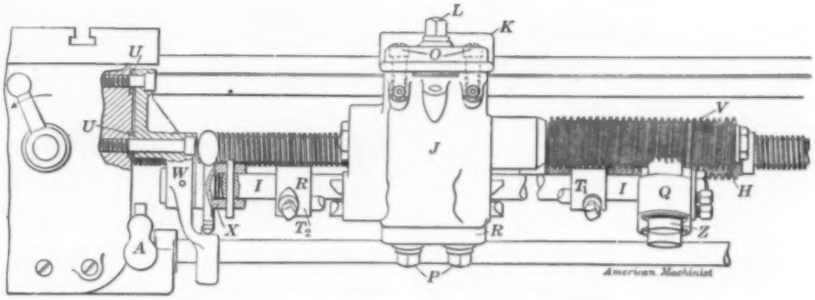


FIG. 3. FRONT ELEVATION OF THE ATTACHMENT

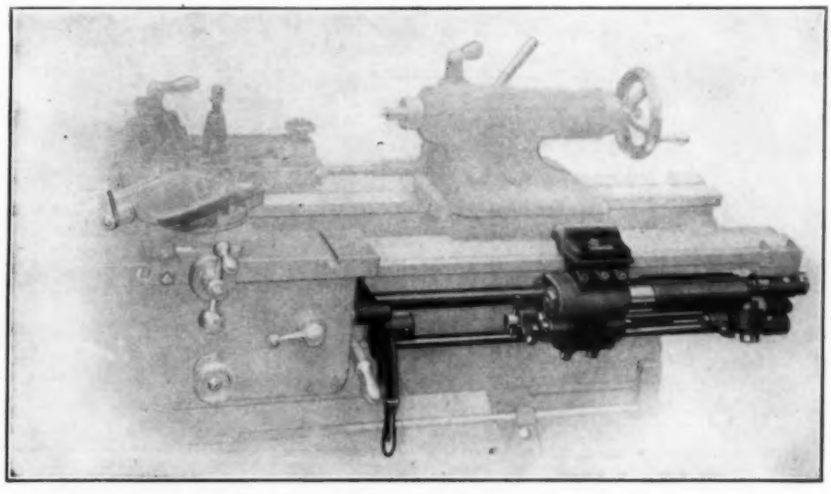


FIG. 2. THE ATTACHMENT OUT OF THE WAY AT THE END OF THE BED

in one direction when *Z* and *Y* are in engagement, and very rapidly in the other direction when *Zr* and *H* are in engagement. The dogs *T* determine the limits of this travel by striking the stop pins on the bracket *J* and throwing the rocker *Q* and handle *X* to neutral position, in which position neither nut is in engagement.

Suppose, for example, we are cutting a right-hand thread. Assume that the gear box has been set for the desired pitch. Throw the regular reverse handle shown at *A* away down and leave it there. Clamp the attachment tightly to the bed by means of the clamp screw *L* at a point which will allow of the desired amount of travel. Throw the handle *X* to the neutral position, as shown in Fig. 4. Four dogs are sent with the attachment, two are marked *R*

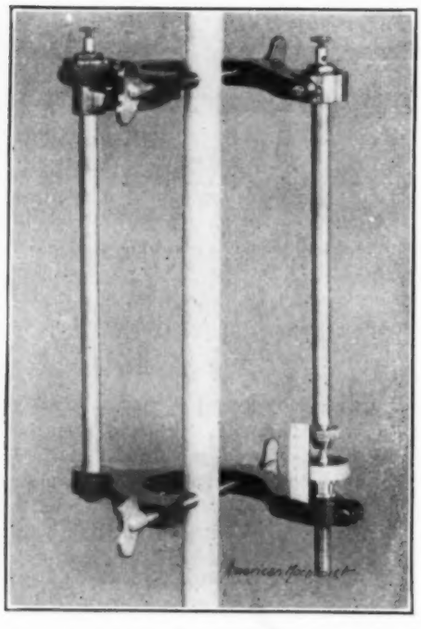
and two *L*. Select the two marked *R*, as these are for use when cutting right-hand threads. They will be seen to be exactly alike. Slip these on the shaft *I*, as shown in Fig. 3, and connect *I* and *X* by the taper pin. Set the dogs *T*1 and *T*2 by running the carriage by hand to the desired place of stoping, sliding the corresponding dog until it hits the stop pin, then tightening the dog. Suppose now, we are all ready to take the first cut with the carriage at the tailstock end and the lathe in motion. Throw the handle *X* up to the cutting position, keeping pressure on the handle until the nut *Z* slips into its thread on *Y*. The carriage travels until the dog *T*1 throws the rocker out, and the handle to neutral position. After drawing the tool out, throw the handle *X* smartly down to the reverse position. Don't be afraid to throw the handle in hard. The carriage travels back very rapidly until the dog *T*2 throws *Zr* out of engagement with *H* and the carriage stops. This is repeated as often as necessary to complete the thread.

When cutting left-hand threads, remove the right-hand dogs and substitute those marked *L*. Throw the regular reverse handle *A* way up and leave it there.

The operation is the same as for right-hand threads, except, of course, that the quick return is toward the headstock.

Extensometer for Tension Tests

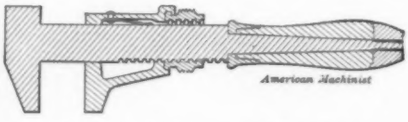
Riehlé Brothers Testing Machine Company, of Philadelphia, Penn., has recently designed and begun to manufacture the extensometer shown in the illustration. The test piece is clamped between four hardened steel, pointed thumb screws, in two yokes held apart adjustably, by the rod on the left. The upper yoke is hinged to the left-hand rod, and by means of the lever construction the deformation of the piece is multiplied by 2 in the reading of the micrometer of the right of the bottom yoke. Provision is made for the usual electric buzzer for accurate determination of micrometer contact. The micrometer readings are to 0.0001 inch. The bars are easily changed for any length of specimen without the necessity of laying off. It is claimed that by this arrangement it is necessary to read only one micrometer, whose indications being twice as great as the extension of the test piece, may be accurately determined.



MULTIPLYING EXTENSOMETER FOR TENSION TESTS

A New High Speed Wrench

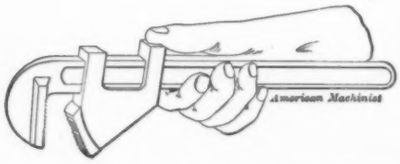
The line cut shows a quick-acting wrench which has been brought out by the Detroit Model Machine Works, Fremont, Ohio. The threads are formed on one side only of the bar. The nut is of such size that it can be thrown out of engagement with the threads on the bar and the sliding jaw, and nut moved in either direction on the bar. This not only gives the quick action of the ratchet wrench, but the close adjustment of the screw wrench.



A NEW HIGH-SPEED WRENCH

A Quick Acting Pipe Wrench

The Wright Wrench and Forging Company, Canton, Ohio, is placing on the market a new quick-adjustable wrench, shown in the cut. It requires but one hand to instantly adjust it to any size pipe.

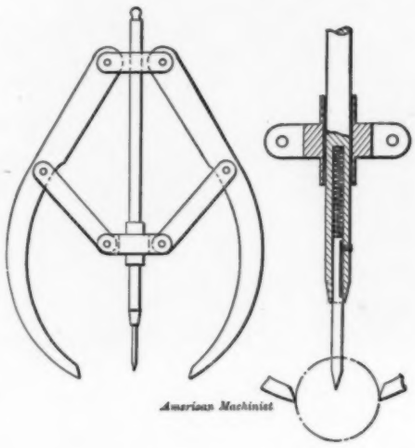


A QUICK-ACTING PIPE WRENCH

Center Calipers

The line cut shows a pair of calipers which has been invented by Wm. H. Harris, Laurium, Houghton county, Mich.

The caliper is intended for automatically finding the centers of bodies of various cross sections. The legs are linked together about the central bar, which is hollow, to accommodate the scribing point and helical spring, as shown.

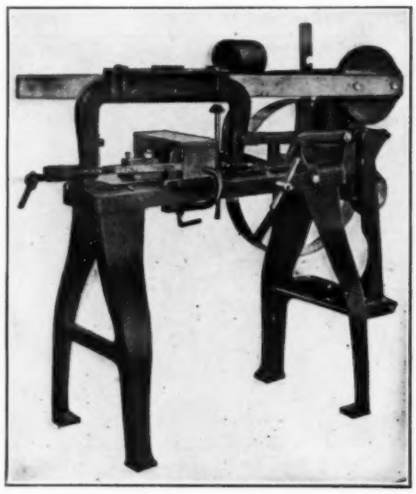


CENTER CALIPERS

A Power Hack Saw Machine

The Massachusetts Saw Works, Chicopee, Mass., have recently added to their line the 6-inch hack-saw machine illustrated herewith.

It is provided with an adjustable stop so that cuts can be made to any desired depth, has quick return stroke, stops automatically and there is a rest for the piece being cut off, which prevents the blades from getting broken when the piece falls. The saw lifts on the return stroke, which increases the life of the blades.



A 6-INCH POWER HACK-SAWING MACHINE

Types of Aeroplanes in Recent Meet

A Notable Collection of Biplanes and Monoplanes

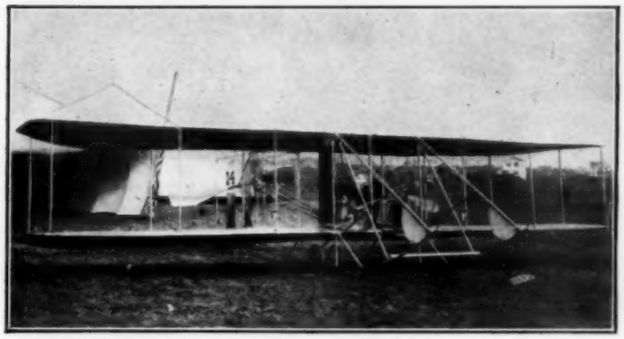


FIG. 1

Improved model Wright Brothers' regular type passenger-carrying machine, with elevating planes in the rear, and vanes to prevent drifting in front. Provided with both wheels and skids. Motor 25 to 30 horsepower.

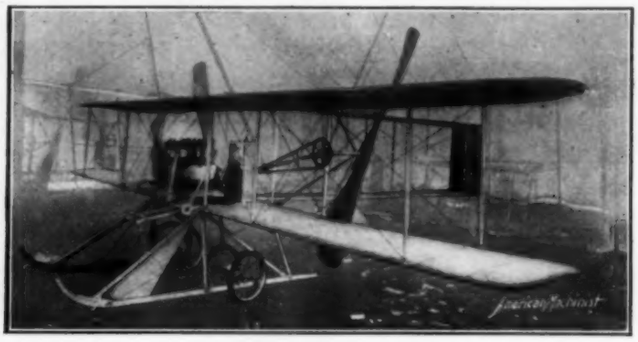


FIG. 2

Wright Brothers' racing aëroplane. Length of planes 21 feet, width 3½ feet, area of both planes 180 square feet. Regular motor. This machine was used by Johnstone in his record altitude flight of 9714 feet.

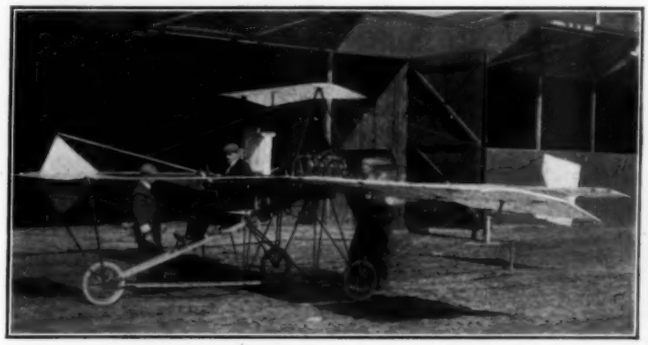


FIG. 3

Curtiss' racing aëroplane, differing from the regular type in having the upper plane very small in comparison with the lower one. Eight-cylinder motor used.

FIG. 4

Curtiss' latest model of regular type biplane. The ailerions are attached to the rear of the main planes instead of being midway between them.

FIG. 5

Curtiss' type biplane used by Hamilton. The ailerions are midway between the main planes.

FIG. 6

Cristie monoplane. An American machine, having two propellers on the engine shaft, motor cylinders arranged in a circle, but stationary.

FIG. 7

The Harmon biplane, built by the Curtiss factory in Hammondsport, N. Y.

FIG. 8

A special type of machine, not flown during the meet, but to be tried out later. Built for Mr. Harmon.

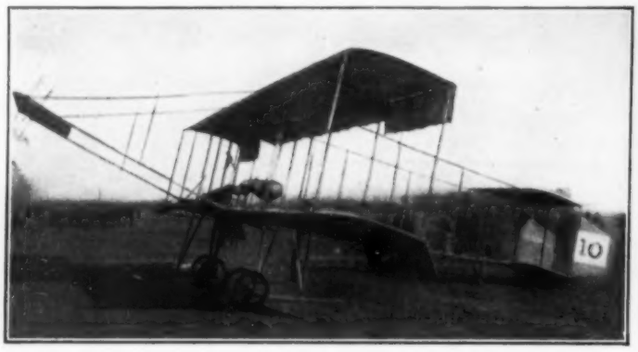


FIG. 9

Grahame-White's Farman machine. Used in passenger-carrying flights.

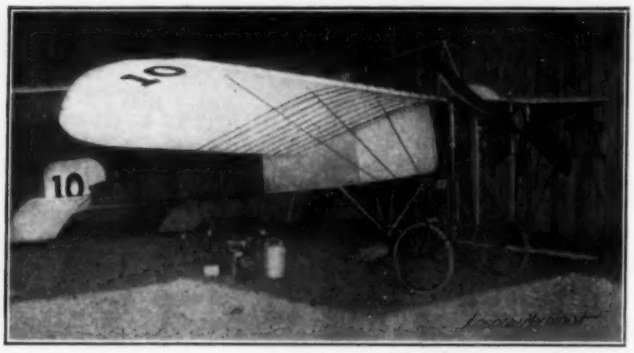


FIG. 10

Grahame-White's Bleriot machine, with 100-horsepower Gnome motor. The machine used by him in his winning speed flight for the International Aviation trophy.

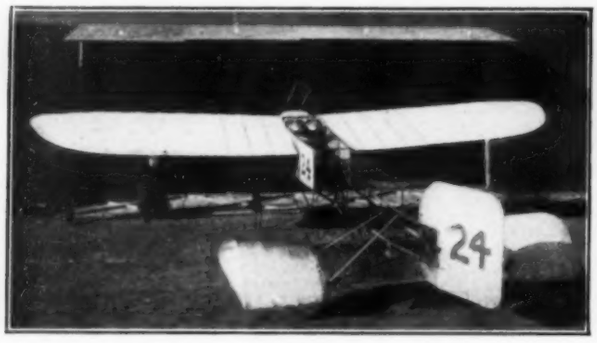


FIG. 11

Regular type 50-horsepower Bleriot monoplane. The type used by Moisant in his winning flight around the Statue of Liberty.

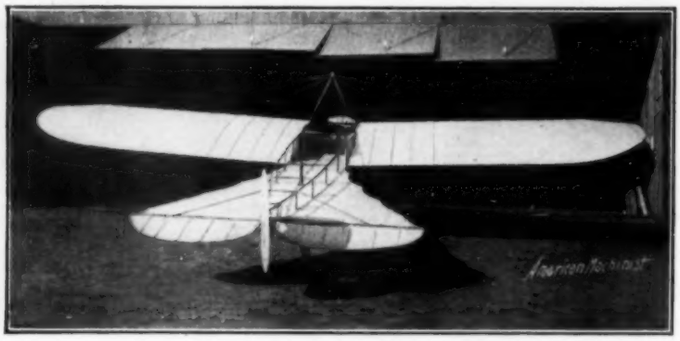


FIG. 12

Latest type Bleriot monoplane. Note the change in tail design, giving a fan effect.

FIG. 13

The Antoinette monoplane used by Latham.

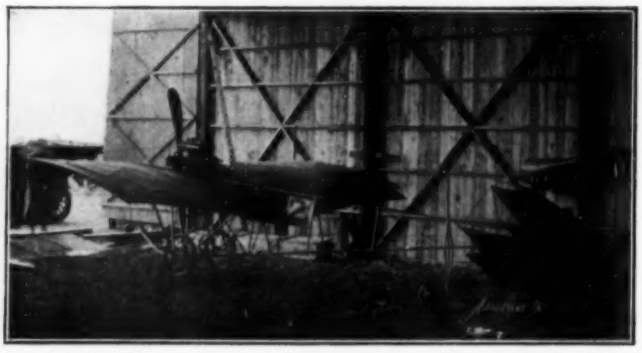


FIG. 14

The Demoiselle used by Audemars.

Increasing Shop Capacities

METAL WORKING

NEW ENGLAND

The Morgan Spring Company, Worcester, Mass., is building an addition.

The Connecticut Clasp Company, Bridgeport, Conn., is erecting a factory.

The American Wringer Company, Auburn, N. Y., will move its plant to Woonsocket, R. I.

The New London (Conn.) Ship and Engine Company is erecting a new machine shop.

The Franklin Square Auto Company, Boston, Mass., is in the market for a screw-cutting lathe.

The Boston & Maine Railroad will erect a machine and repair shop at North Adams, Mass., to cost $25,000.

The H. D. Smith & Co.'s carriage hardware plant, Southington, Conn., was destroyed by fire. Loss, $200,000.

J. J. Adams, Worcester, Mass., manufacturer of cutting dies and machinery, is putting up a new machine shop.

Ellis & Lincoln, metal novelty manufacturers, Providence, R. I., will move their factory to 100 Friendship street.

The J. L. Thomson Company, Waltham, Mass., will build an addition. The company manufactures rivets and buckles.

The Goodell-Pratt Company, Greenfield, Mass., will make an addition to its factory to be used for manufacturing purposes.

The Morse Twist Drill and Machine Company, New Bedford, Mass., will erect an addition to be used for manufacturing purposes.

The Metal Products and Screw Machine Company, Providence, R. I., will add one story to the main building to be used for manufacturing purposes.

MIDDLE STATES

The Proctor and Gamble Company is adding to its machine shops at Ivorydale, Ohio.

The Imperial Pneumatic Tool Company, Athens, Ga., is building an addition to its plant.

Plant of the Hardware and Supply Company, Akron, Ohio, was destroyed by fire. Loss, $150,000.

R. R. Fray, of the Fray Jewelry Company, Detroit, Mich., will start a branch factory in Providence.

William Hirsch will build a two-story machine shop at 5320 St. Clair avenue, N. E., Cleveland, Ohio.

The Illinois Watch Company, Springfield, Ill., has taken out a permit for the erection of a two-story addition.

The Weaver & Little Company, Lebanon, Penn., is building a new factory to manufacture wheat separators.

The Pittsburg (Penn.) Machine Company has purchased site east of Copeland station, Braddock, and will erect a plant which will employ over 300 men.

The Suspension Roller Bearing Company, of Sandusky, Ohio, is planning to erect a large factory building, which will give employment to 1000 men.

The Western Stove and Range Company, Chicago, Ill., has been incorporated with $20,000 capital by Bernard W. Kunkel, Paul A. Kunkel, Wm. F. Falter.

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

The National Bolt and Nut Company, Pittsburg, Penn., has awarded contract for the erection of several buildings and will let contracts for additional equipment.

At Elyria, Ohio, the Machine Parts Company, which was recently chartered to manufacture steering gears and aluminum castings for automobiles, will erect a plant.

The Standard Automatic Machine Company, New York, has incorporated to manufacture and deal in machinery. Capital, $50,000. Incorporators, L. Sachs, B. H. Levy, C. J. White.

The Standard Garage Company, Toledo, Ohio, has been incorporated with $20,000 capital to operate a garage and repair shop. Incorporators, R. A. Parker, J. P. Searles, N. M. Turner, etc.

The Punches Repeating Arms Company, Toledo, Ohio, has been incorporated to manufacture all kinds of fire arms. Incorporators, B. W. Punches, Otto Koehler, E. W. Doherty, etc. Capital, $20,000.

The Milwaukee (Wis.) Machine Tool Company, which has just completed the erection of a new plant at Mitchell street and Sixtieth avenue, has decided upon the erection of an addition to same.

Work has begun on additional buildings at the yards of the American Ship Building Company, Lorain, Ohio, which include machine shop, foundry, pattern shop. About $1,000,000 will be expended.

The Bullis Manufacturing Company, Rochester, N. Y., has been incorporated to manufacture automatic pop-corn machines. Capital, $50,000. Incorporators, F. O. Bullis, F. C. Roy, W. F. Chandler.

The Gyro Motor Company, Cleveland, Ohio, has incorporated to manufacture and sell motors for automobiles and other purposes. Capital, $10,000. Incorporators, C. W. Hunt, W. L. Cary, H. R. Palmer, etc.

The Low Speed Turbine Company, Camden, N. J., was incorporated to manufacture automobiles, airships, motor cycles, etc. Capital, $100,000. Incorporators, John A. MacPeak, Harvey L. Reese, J. Hunter Gaul.

The Interstate Heater Company, Cleveland, Ohio, has been incorporated to manufacture and sell heating and ventilating apparatus. Incorporators, A. Bromberger, Gottlieb Mueller, A. Rosen, etc. Capital, $100,000.

The Consolidated Casting Company, Mechanicville, N. Y., was incorporated to manufacture castings. Capital, $200,000. Directors are A. C. Kniskern, Ford Packer and R. V. Tompkins, of Mechanicville, etc.

The E. H. Henderson Company, Chicago, Ill., has been incorporated with $50,000 capital to do a forging, manufacturing and blacksmithing business. Incorporators, E. H. Henderson, Geo. A. Henderson, Robt. R. Hindenach.

The Hays-Schoepflin Company, Buffalo, N. Y., has incorporated to manufacture automobiles and autotrucks. Capital, $10,000. Incorporators, Walter Hays, B. I. Hays, B. I. Hays, Louis G. Schoepflin, L. O. Schoepflin.

The Edmunds & Jones Manufacturing Company, Detroit, Mich., would like to receive catalogs from manufacturers of sheet-metal machinery, plating, electrogalvanizing and enameling processes and electric-lamp accessory devices.

The Raymond Manufacturing Company, Corry, Penn., whose plant was noted as burned in the October 27 issue, say fire was confined to a new addition not yet occupied and the manufacturing departments were not interfered with.

The Yoe Voting Machine Company, Columbus, Ohio, has been incorporated with $10,000 capital to manufacture voting machines, invented by Philip Yoe. Incorporators, Philip Yoe, K. Fitzpatrick, Judge R. W. Baggott, etc.

The National Enameling and Machine Company, Youngstown, Ohio, has been incorporated to manufacture and sell enameling and steel articles. Incorporators, William Wilkoff, L. J. Campbell, James P. Wilson, etc. Capital, $25,000.

The Burglar Alarm and Automobile Bell Manufacturing Company, New York, has been incorporated to manufacture alarms, signals, etc. Capital, $100,000. Incorporators, W. A. Boeckel, S. Tekulsky, New York; J. H. Hopkins, Paterson, N. J.

The William Corliss Engine Company, of New York, has been incorporated for the purpose of manufacturing machinery, engines, etc. Capital, $200,000. Incorporators, W. Corliss, I. G. Ladd, Providence, R. I.; E. W. Corliss, New York.

The Victor Appliance Company, Watervliet, N. Y., has been incorporated to manufacture automobile and motorboat specialties and to do general repairing. Directors are Augustus Bigelman, Gustavus Garrow, De Witt Tappan, all of Watervliet.

The Beloit Lighting and Heating Company, Beloit, Wis., has been incorporated to manufacture appliances for making gas from gasolene for lighting and heating. Capital, $30,000. Incorporators, H. W. Adams, Chas. H. Jones, S. G. Strong.

SOUTHERN STATES

The Union Foundry Company, Anniston, Ala., will enlarge its plant.

The Veitch-Matthews Engineering Company, Bessemer, Ala., has reorganized and will erect a factory for the manufacture of rotary engines. Mayor I. A. Lewis is president.

The Hearne Motor Company, Wheeling, W. Va., has been incorporated to manufacture automobiles. Capital, $20,000. Incorporators, J. G. Hearne, Thos. McK. Hearne, S. A. Williams, etc.

WEST OF THE MISSISSIPPI

Robert Bush will build a blacksmith shop at Tecumseh, Neb.

N. D. Mercure, of Mullen, Neb., will erect a new blacksmith shop at that place.

The St. Louis (Mo.) Car Company is being reorganized and its plant will be enlarged.

Chás. Leonhardt will erect a one-story machine shop and foundry at New Ulm, Minn.

M. A. Wiser, Los Angeles, Cal., will erect a machine and blacksmith shop on West Albion street.

Gross Brothers, Eugene, Ore., machinists and iron founders, are building an addition to their machine shop.

Machinery and equipment will be required in the new Polytechnic High School to be erected at San Diego, Cal.

Nichols & Co., manufacturers of metal building appliances, are moving to Los Angeles, Cal., from Oakland, Cal.

The "A" Automobile Manufacturing Company, San Francisco, Cal., is looking for a site on which to erect a plant.

Douglas A. Fiske, of Minneapolis, Minn., will have a three-story garage built at Eighth street south and Hennepin avenue.

Grantham Bros., of Emerado, N. D., are considering the erection of a plant for a foundry and machine shop at Lankin, N. D.

The Los Angeles Railway Company, Los Angeles, Cal., contemplate the erection of a large plant for the manufacture of street cars.

The Brawley Hardware Company, Brawley, Cal., will have a new building in this city to be erected for them by W. F. Holt, of Brawley.

A commercial garage and repair station will be erected at Santa Barbara, Cal., by Earl G. Hayward, of the sme city. Modern equipment required.

The Parlin & Orendorff Machinery Company, St. Louis, Mo., has commenced the erection of a $250,000 building on Broadway, near Benton street.

The Coffeyville (Kan.) Foundry and Machine Company will install a number of new machine tools and begin the manufacture of gasolene traction engines.

The Afterthought Copper Company, Ingot (Shasta county), Cal., is making extensive improvements in its mine in machinery equipment, retimbering, etc.

The Hot Blast Oil Burner Company, Springfield, Mo., has been incorporated to manufacture crude-oil burners. Capital, $15,000. Incorporators, W. A. C. Murphy, J. W. Roberts, A. S. Cowden, C. A. Hubbard.

Wichita, Kan., is building a new high school, which will be equipped thoroughly for manual training, including metal and wood work and mechanical drawing. Lewis Neuenschwander, director manual training.

An independent steel plant to cost $10,000,000 will be built in the vicinity of San Pedros (Los Angeles). L. S. Barnes, Central building, Los Angeles, Cal., is at the head of the enterprise. It is contemplated to begin construction by January 1.

CANADA

G. Lawrence, of Toronto, is building a large garage.

The Gurney Scale Company, Hamilton, Ont., is building a new factory.

The Winkley Fire Arms Company will locate a plant at Windsor, Ont.

H. Disston & Sons, saw manufacturers, are building a large factory in Toronto.

The Ottawa Car Company is building a large addition to its plant at Ottawa.

The Canadian Northern will build extensive repair shops at Parry Sound, Ont.

The Orient Railway will build a roundhouse at Altus, Okla., to cost $14,000.

The Maximilian Machine and Tool Company will locate a new factory at Woodstock, Ont.

The Cockshutt Plow Company, of Brantford, is building large extensions to its factory.

The McLaughlin Buick Automobile Company is building a large factory in London, Canada.

The Canadian Overland Company will erect a large auto-manufacturing plant at Regina, Saskatchewn.

The Ontario Wind Engine and Pump Company is building a $100,000 factory at Winnipeg, Manitoba.

The Gurney Tilden Stove Manufacturing Company is building a large new shop at Hamilton, Ont.

The Acme Motor Carriage and Machine Company will build a large new factory at Hamilton, Ont.

The Percival Plough and Stove Company, Merrickville, Ont., will rebuild its factory destroyed by fire.

The Massey-Harris Company, of Toronto, is building an addition to its plant. The concern manufactures reapers.

At Campbellton, N. B., the W. J. Duncan foundry, the McLennan machine shops, the Harquail woodworking establishment are being rebuilt.

The Alberta Iron Rolling Mills Company, Medicine Hat, Alta., will expend in the near future about $10,000 in construction and about $80,000 in machinery, etc.

General Manufacturing

NEW ENGLAND

D. J. Burke, Rockland, Mass., will install an engine and boiler.

The town of Medway, Mass., will install a complete waterworks system.

The Reliance Worsted Company is opening a plant at Olneyville, R. I.

Malvern Hotel, Bar Harbor, Me., will erect an addition to be steam heated.

The Litchfield Shuttle Company is to build a new plant at Southbridge, Mass.

The Dane Machine Company, Salem, Mass., is in the market for a steam boiler.

The town of Wellesley, Mass., will erect a school house, to be steam heated.

The Booth Mill, New Bedford, Mass., will install a complete new power plant.

The town of Revere, Mass., will erect an 18-room school house to be steam heated.

The town of Athol, Mass., is boring artesian wells and will require pumping machinery.

The Worcester Consolidated Street Railroad is to equip a power house at Millbury, Mass.

The First National Bank of New York, 2 Wall street, will install a boiler and engine.

The McKinley Fish and Freezing Company, Tremont, Me., will install a cold-storage plant.

The Miamus Motor Company, Miamus, Conn., will install an electric drive in its new shop.

The Berkshire Brewing Company, Pittsfield, Mass., will erect an addition to its bottling plant.

The Edison Electric Illuminating Company, Boston, Mass., is to erect additions to its plant.

The Leominster (Mass.) Electric Light and Power Company is planning to erect an addition.

The Taplin Manufacturing Company, New Britain, Conn., is in the market for electric motors.

The Commercial Auto Works, Hyde Park, Mass., is in the market for horizontal-tubular boilers.

The Greendale Lumber and Supply Company, Worcester, Mass., will purchase electric motors.

Grain elevator and plant of J. Loring & Co., Watertown, Mass., was burned. Loss, $50,000.

The Slater Manufacturing Company, Pawtucket, R. I., is erecting a large addition to its mill.

Shingle mill of the Union Lumber Company, Natick, Mass., was burned. Loss, $25,000.

The Worcester Consolidated Street Railway, Millbury, Mass., will install coal-conveying apparatus.

The Lewiston Bleachery and Dye Works, Lewiston, Me., will make a large addition to its plant.

C. W. Dean & Co., Cochituate, Mass., manufacturing shoes, is erecting a new plant at Natick, Mass.

The Fabrican Company has purchased a mill in Medway, Mass., and will install textile machinery.

E. P. Reed Lumber Company, North Abington, Mass., will erect a coal pocket and install a conveyer.

H. G. Fairfield, 20 Kelly street, Boston, Mass., is in the market for a 75-horsepower boiler and engine.

The Otis Company, Three Rivers, Mass., is enlarging its power house and will install water wheels and accessories.

The International Rubber Company, West Barrington, R. I., is contemplating installing a 25-horsepower electric motor.

Cheney Brothers, South Manchester, Conn., are planning to erect a new spinning mill, which will employ 700 additional hands.

The Union Electric Company, Lewiston, Me., is preparing plans for the construction of a hydroelectric station at Clark's Rips, Me.

J. Stevens Arms and Tool Company, Chicopee, Mass., is making additions to the power plant and require some new equipment.

The Frost Finishing Company, West Barrington, R. I., is preparing to equip a chemical laboratory. Will probably purchase a motor.

The Rhode Island Company is planning to remodel its power house in Providence, and will install a 20-000-horsepower steam turbine.

Eugene S. Graves, formerly superintendent of the Agawan Finishing Company, of Wareham, Mass., is negotiating for the purchase of land in New Bedford, on which to erect a bleachery.

MIDDLE STATES

The Clayville (N. Y.) Knitting Company is planning to enlarge its plant.

The Warsaw (N. Y.) Paper Box Company has completed its new plant.

The Harrisburg (Penn.) Silk Company is planning to enlarge its ribbon mill.

The Hillside Chemical Company, Newburgh, N. Y., will erect a two-story addition.

Fire destroyed the plant of the Lawton (Mich.) Basket Company. Loss, $25,000.

The Preston Leather Company, Newark, N. J., is building an addition to its factory.

New boilers, costing $6000, will be installed at the Soldiers and Sailors Home, Bath, N. Y.

Fire did $10,000 damage at the plant of the American Bottle Company, Newark, Ohio.

The Arcade Company will build a refrigerating plant at 1412 Park road, N. W., Washington, D. C.

The Furnas Office and Bank Furniture Company, Indianapolis, Ind., is rebuilding its plant recently burned.

John Kelly will build a planing and finishing mill and woodworking shop at Malone, N. Y.

The Dairymen's Manufacturing Company, Jersey City, N. J., will build a new power house.

The city of Grand Rapids, Mich., is in the market for electric generators and automatic stokers.

The Felber Company, of Columbus, Ohio, is planning to construct a plant on Grove street.

Fire destroyed the stair factory of Jacob Haney, East Liberty, Penn., causing a loss of $60,000.

The city of South River, N. J., is in the market for a complete electric-light and power plant.

The Edward Ford Plate Glass Company will erect additional buildings at its plant in Rossford, Ohio.

Fire caused $10,000 damage to the plant of the Johns-Manville sheet cork works at Newark, N. J.

Improvements to cost $7000 will be made at the steam plant of the Rome (N. Y.) Custodial Asylum.

The Wilton Light and Power Company, of Wilton, Wis., has a franchise to construct a light and power plant there.

The Darlington Electric Company's power house, at Darlington, Wis., was destroyed partially by fire. Loss, about $5000.

The National Fireproofing Company, of Pittsburg, Penn., is said to be contemplating the erection of a plant in the South.

At Cleveland, Ohio, the Tennis-Euclid Improvement Company plans to erect a large knitting factory on East Fifty Seventh street.

The Newark (N. J.) Brush and Scraper Company has purchased property at Frelinghuysen avenue and Alpine street for a new factory.

Kaltenbach & Stevens, silk-ribbon manufacturers, East Allentown, Penn., have awarded contract for the erection of a finishing mill in Newark, N. J.

Burdell & Co., of Columbus, Ohio, has purchased the plant of the American Sand Company, at Dundee, Ohio, and will operate the property in the future.

Item published in the October 20 issue that the Boyerstown Casket Company, Philadelphia, Penn., will install two new engines is incorrect, as such is not the intention at present.

Francis W. Brady, 95 Liberty street, New York, is in the market for small rotary air compressors, and rotary or centrifugal pumps for direct connection to standard electric motors.

The Match Supply Company, Valatie, N. Y., was incorporated with $150,000 capital to manufacture matches. Incorporators, Edwin D. Howe, Valatie. J. Sheldron Frost, Albany, etc.

The capital stock of the Mt. Vernon Electric Company, of Mt. Vernon, Ohio, has been increased from $10,000 to $300,000 for the purpose of erecting a new power house and extending the lines.

The Findlay Electric Porcelain Company, Findlay, Ohio, has been incorporated to manufacture and sell all kinds of porcelains. Incorporators, Merle N. Poe, William E. Van Eman, M. W. Diggs, etc. Capital, $25,000.

The National Telephone Supply Company, of Cleveland, Ohio, was incorporated with an authorized capital of $20,000 to manufacture and sell all kinds of telephone equipment by F. H. Pelton, William H. Mariatt, M. Jenkins, F. B. Bolton and M. B. Campbell.

SOUTHERN STATES

The Bay View Asylum, Baltimore, Md., will build a new $150,000 power house.

The Vance Cotton Mill, Salisbury, N. C., is having plans prepared for enlargement of its plant.

W. T. Brooke, Norfolk, Va., is in the market for electrically driven centrifugal pumping machinery.

The Harbison-Walker Refractories Company will spend $100,000 in enlarging its brick at Wylam, Ala.

The Southern Equipment Company, Birmingham, Ala., is in the market for an electrically driven air compressor.

The plants of the Southern Oil Company and Atlantic Ice and Coal Corporation, Macon, Ga., were destroyed by fire. Loss, $225,000.

WEST OF THE MISSISSIPPI

W. H. White will build a broom factory at Moulton, Iowa.

The plant of the Diamond Match Company, Stirling City, Cal., was burned.

A new power plant to cost $50,000 will be erected at Webster City, Iowa.

Allan R. Laidlaw, Porterville, Cal., is building an addition to his planing mill.

W. O. Swenson's feed mill, at Church's Ferry, N. D., was destroyed by fire.

The city of Vale, Ore., contemplates the installation of a municipal water system.

The Redlands Orange Growers Association, Redlands, Cal., will build an addition.

The Southern California Edison Company will erect a gas plant at Pomona, Cal.

The city of Tracy, Cal., contemplates the installation of a municipal water plant.

The National Lumber Company, Pasadena, Cal., is building an addition to its plant.

The Pine Mountain Water Company, Maricopa, Cal., will install a new water system.

The Colton Fruit Exchange, Colton, Cal., has commenced work on a new packing house.

The Western Smelters Corporation, of Carson City, Nev., will erect a new power plant.

The Fort Scott (Kan.) Light and Railway Company will install new generators and engines.

Herman Anderson, of Rush City, Minn., is considering the erection of an electric-light plant.

The Electric Light Company, at Spring Valley, Minn., will install a number of motors.

The planing mill of the Harrisburg (Tex.) Lumber Company was destroyed by fire. Loss, $50,000.

Fire destroyed the plant of the Fairmount Creamery Company, Omaha, Neb. Loss, $60,000.

The city of Porterville, Cal., contemplates the installation of a new system of street lighting.

The Northwest Paper Company, of Brainerd, Minn., has plans for the erection of a paper mill.

The Mesa Dairy and Ice Company, Mesa, Cal., will increase the capacity of its ice-making plant.

The Orange Growers Association, Redlands, Cal., has commenced improvements on its packing house.

Steam-heating equipment will be required in the new St. Joseph's hospital addition at Prescott, Ariz.

W. N. McGill and J. W. Adams, of Ely, Nev., will erect a large packing house and cold-storage plant.

The Pomona Valley Creamery, Pomona, Cal., will build a creamery. Modern equipment will be installed.

The Kingsley Chemical Reduction Company, of Spokane, Wash., has purchased site at Dishman for a new plant.

The Randolph Fruit Company, Redlands, Cal., is making extensive improvements in its packing house and facilities.

A 250-kilowatt generator and engine will be added to the equipment of the municipal lighting plant at Chanute, Kan.

New machinery will be required by the *Los Angeles Times*, Los Angeles, Cal., whose entire plant was recently destroyed.

The Oceanside Gas and Electric Comapny, Oceanside, Cal., is planning the erection of an electric plant at Fallbrook, Cal.

The Tula Rosa Copper Company, Tula Rosa, New Mexico, will increase the capacity of its crushing and concentrating plant.

It is announced that the Twin City Light and Traction Company, Centralia, Wash., will build a new power plant to cost $150,000.

The Redlands Coöperative Association, Redlands, Cal., will erect a large packing house. Modern equipment will be installed.

The Minneapolis Gas Light Company will erect a $39,500 plant at Bluff street and Nineteenth avenue, South Minneapolis, Minn.

R. A. Fullerton and Charles W. Lange, of Minneapolis, Minn., are considering the erection of a large flour mill at Livingston, Mont.

The Columbia Incandescent Lamp Company, St. Louis, Mo., will erect a new $75,000 factory at Etzel avenue and Wabash tracks.

It is announced that the concentrating plant of the Tularso Copper Company, Tularso, New Mexico, will be increased in capacity.

The Alamitos Water Company, Long Beach, Cal., will make extensive improvements in its water system. It plans to double present capacity.

The American Olive Company, whose plant was recently destroyed by fire, has begun the erection of a new factory building in Los Angeles, Cal.

The Los Angeles Railway Company, Los Angeles, Cal., has completed a new building for use as a station for generating equipment at Gardena, Cal.

R. W. Knowles and associates have purchased the electric-light plant at Farmington, New Mexico, and will expend about $100,000 in improvements.

The Riverside Portland Cement Company, Riverside, Cal., will make extensive improvements and additions to its plant. $400,000 will be expended.

The Mesa Ice and Cold Storage Company, Mesa, Cal., will increase the capacity of its cold-storage plant and will also purchase ice-making machinery.

A steam-heating and vacuum-cleaning system will be required in the new store and hotel building to be erected in Los Angeles, Cal., by R. J. Cope.

It is announced that a representative of Swift & Co., Chicago, has been at San Diego, Cal., to select a site for a packing plant to cost about $250,000.

Announcement is made that the Klamath Falls Light and Water Company, Klamath Falls, Ore., will double the capacity of its plant in the near future.

The Wessel Mining and Smelting Company, near Casa Grande, Ariz., will make extensive improvements in its plant. Mining machinery and boilers will be required.

The Los Angeles Investment Company, builders of homes, Los Angeles, Cal., will erect a manufacturing plant at Western and Slauson avenues to cost $500,000.

Tarber Montgomery, Fullerton, Cal., has purchased the plant of the Fullerton Domestic Water Company. Extensive improvements will be made in the system.

The Noble Electric Steel Company, Redding, Cal., is preparing plans and specifications for five new furnaces for the production of pig iron. About $300,000 will be expended.

A system of steam heating and ventilation will be installed in the new theater at Phœnix, Ariz., to be erected by W. H. Nall and Henry Ware. Plans are now nearing completion.

The California Natural Gas Company, headed by B. C. Oliphant, of Buffalo, N. Y., will build a plant in the Midway district, in the vicinity of Bakersfield, Cal. Operations will begin in December.

The San Diego Paint and Fuel Company, San Diego, Cal., will erect a plant for the manufacture of paint, oil and fuel oil; a boiler, two condensers, pumps, tanks and one still will be installed.

Power-plant equipment will be required in the new 10-story office building to be erected at Fifth and Spring streets, Los Angeles, Cal., by the Chester Fireproof Building Company. Construction will start in December.

CANADA

George Weston is building a large biscuit factory in Toronto.

The Wunder Furniture Company, of Berlin, is doubling its factory.

Brandon, Manitoba, will spend $50,000 for waterworks extensions.

Chilliwack, B. C., will install a complete new waterworks system.

The Marine Construction Company is building a factory in Toronto.

St. Catherines, Ont., will spend $75,000 for waterworks extensions.

The town of Duncan, B. C., will install a complete electric equipment.

The Canadian Tube Company will build a large factory at Emard, Que.

The Scout Shoes Company will equip a $100,000 factory in Montreal.

Regina, Saskatchewan, will spend $100,000 on electric railway equipment.

The Canadian Feather Mattress Company will build a factory at Ottawa.

Biggar, Saskatchewan, will spend $15,000 for new waterworks machinery.

The Empress Electrical Works will locate a big plant at Vancouver, B. C.

The Western Canada Power Company will locate a big plant at Coquitlam, B. C.

The Canada New Shoe Company will locate a large factory at Harriston, Ont.

The Port Arthur Wagon Company is building a large factory at Port Arthur, Ont.

W. Hanham is interested in a large packing plant to be located at Duncan, B. C.

The Electro Power Company, of Belleville, is building large additions to its plant.

R. P. Butchart will locate a big portland-cement factory at St. Boniface, Quebec.

The Dominion Wood Pipe Company, of New Westminster, will extend its plant.

The Bolton Light, Heat and Power Company will equip a plant at Bolton, Ont.

The Robert Stewart Company will equip a large planing mill at Toronto, Canada.

The Tetrault Boot and Shoe Company is building a big factory at Maisonneuve, Que.

H. E. McArthur's woodworking factory at Halifax, N. S., destroyed by fire, will be rebuilt.

The Canadian Light and Power Company, of Montreal, is making extensions to its plant.

The Dupuis Pulp and Lumber Company will locate a big plant at St. Hermengilde, Quebec.

The Vancouver Sewer Pipe and Refractories Company will locate a large plant at Vancouver, B. C.

Messrs. Ross & Holgate, of Montreal, will build a very large new power house on the Magog river.

The Light and Heat Commission, at Stratford, will make extensive additions to its power station.

W. M. Aitken, of Quebec, is interested in the building of a large plant there to manufacture paper.

The St. Lawrence Flour Milling Company will spend $50,000 on new machinery for its Montreal mill.

The Winnipeg Ceiling and Roofing Company is building a $60,000 plant at St. Boniface, Manitoba.

The Fleming-Gibson Company will equip an immense lumber mill and shops at Woodstock, New Brunswick.

The sash and door factory of C. Caron, at St. Cyrille de Wendover, Que., was destroyed by fire. Loss, $15,000.

The Manitoba Power Company, whose head office is at Winnipeg, will spend $5,000,000 developing electrical power.

The Rice Malting Company, of St. Boniface, Manitoba, will buy engines and elevators for its new $250,000 brewery.

The Winnipeg Tanning Company, at Winnipeg, will make extensive additions to its plant and install new machinery.

Hugh Armour, of Regina, Saskatchewan, will equip a $500,000 cold-storage plant and abattoir with the latest apparatus.

The Wayagamack Pulp and Power Company, head offices, Montreal, will equip a number of plants throughout Quebec.

The mill of the McLellan Smith Lumber Company, at Burton, New Brunswick, destroyed by fire, will be greatly enlarged.

The Porcupine Power Company, with headquarters at Toronto, will locate a number of plants at different points in northern Ontario.

Business Items

The W. F. & John Barnes Company, Rockford, Ill., has been awarded a gold medal on its display at the Brussels Exposition.

Announcement has been made that the business of William Forgie, Washington, Penn., has passed into the hands of the Duff Manufacturing Company, of Pittsburg, Penn. The latter concern has bought the entire Forgie plant, including its business and all rights and privileges of making the oil-well jacks originated in the early days of the business by William Forgie.

The Northern Engineering Works, Detroit, Mich., is completing an addition to its crane-erecting shop. The new building is approximately 160x60 feet, of fireproof structural steel and brick construction, and having steel sash. Three cranes and two overhead trolley runs will serve the floor. Electric and pneumatic hoists will be used. The machinery has been installed and the building will be occupied this month.

Trade Catalogs

The Hamilton Machine Tool Company, Hamilton, Ohio. Catalog. Lathes, planers, shapers, upright drills. Illustrated, 6½x9½ inches, paper.

Chicago Pneumatic Tool Company, Fisher building, Chicago, Ill. Catalog No. 32. Pneumatic hammers, drills, riveters, etc. Illustrated, 104 pages, 6x9 inches, paper.

The L. S. Starrett Company, Athol, Mass. Catalog No. 19. Fine mechanical tools. Micrometers, speed indicators, steel rules, hack saws, levels, etc. Illustrated, 272 pages, 5x7½ inches, paper.

The Bristol Company, Waterbury, Conn. Bulletin No. 128. Bristol's round form Class H recording thermometers. Bulletin No. 129. Bristol's thermometer-thermostats. Bulletin No. 135. Recording shunt ammeters. Bulletin No. 141. Round-form recording pressure gages. Bulletin No. 145. Class H indicating thermometer. Bulletin No. 146. Long-distance recording tachometer. Bulletin No. 147. Bristol-Durand radii averaging instrument. Illustrated.

Forthcoming Meetings

National Society for Promotion of Industrial Education, fourth annual convention, Boston, Mass., November 17, 18 and 19.

American Society of Mechanical Engineers, annual meeting, December 6-9, New York. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

American Foundrymen's Association, annual convention, Pittsburg, Penn., May 23 to 26, 1911. Richard Moldenke, secretary, Watchung, N. J.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania: monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland: monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Philadelphia Foundrymen's Association; meetings first Wednesday of each month, Manufacturers Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, as-

sociation or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

MISCELLANEOUS WANTS

Caliper catalog free. E.G.Smith, Columbia, Pa.

B. Jahn, New Britain, Conn., makes dies, tools, models and specialties.

Special machinery and tools designed and detailed. Box 146, AMERICAN MACHINIST.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

The "Gas Saver" brazing forge; circular. J. L. Lucas & Son, 2 Fox St., Bridgeport, Ct.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 990 G St., Washington, D. C. Write for Inventor's Handbook.

Wanted—Spur gear cutter to take 8-foot gears; state condition fully and where can be seen. Dillon-Box Iron Works Co., Denver, Colo.

Wanted—One each April and May issues, year 1903, AMERICAN MACHINIST; we will pay premium for same. Stewart & Clark Mfg. Co., 1848 Diversey Boulevard, Chicago, Ill.

Wanted—Automatic screw machine work, up to and including 9/16-inch diameter, for latest multi-spindle machines; prompt deliveries and reasonable prices. Woburn Gear Works, Nashua St., Woburn, Mass.

Large English firm of machine tool importers having showrooms and offices in Great Britain, France, Germany, Italy, India and Japan is wanting good agencies for machine tools of all kinds. Box 189, AMER. MACH.

Wanted—Heavy duty drill guaranteed to be accurate and in prime condition; Colburn Machine Co.'s, Foote-Burt Co.'s, Baker Bros.', 24- to 36-inch swing; in answering give full particulars and state lowest price for cash. Regal Gasolene Engine Co., Coldwater, Mich.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

INDIANA

Foreman—Wanted, a first class reliable man to take charge of motor assembly department in an established automobile factory; must have good references, be thoroughly competent and good producer. Address "G. H. S.," AMERICAN MACHINIST.

MASSACHUSETTS

Head draftsman and designer, experienced on rotary printing presses and folders. Box 132, AMERICAN MACHINIST.

Wanted—First class draftsman; should be up to date on lathe and milling machine design. Box 157, AMERICAN MACHINIST.

Experienced salesman wanted to travel from Boston to Chicago selling an extensively advertised and popular machine tool; state salary desired and past experience in selling. Box 109, AMERICAN MACHINIST.

MICHIGAN

First class horizontal boring machine man; good wages and steady work for the right party; ideal shop conditions. Address Grant & Wood Mfg. Co., Chelsea, Mich.

Wanted—First class toolmaker who has had experience in making tools for trunk and suit case locks and hardware; also press room foreman, who understands setting up tools and running presses. Box 160, AM. MACH.

Wanted—An automatic screw machine man capable of operating National-Acme four spindle and Gridley four and single spindle machines; good wages to right man, capable of getting production; none but experienced need apply. Box 152, AMERICAN MACHINIST.

NEW YORK

Ventilating Engineer—Young phenomenally successful corporation manufacturing labor-saving equipment, is interested in an arrangement with an acknowledged expert in the designing and building of exhaust fans, dust arresters, etc.; must be situated conveniently to New York, where counsel could be had readily; if of advantage consultation could be arranged evenings and holidays; state age, education and experience. Box 130, AMERICAN MACHINIST.

Wanted—Salesmen in all parts of the country, who call on machine shops, to sell on a commission basis, as a side line, high speed twist drills, milling cutters, reamers and other tools; state territory, give references and experience in detail. Box 153, AM. MA.

Mechanical draftsman and designer; opportunity of lifetime with young aggressive manufacturing corporation (where advancement is limited only to the individual ability) for an especially apt, well trained man who has served as chief draftsman with prominent concerns; experienced in ventilating and conveying installations essential; give nationality, age, places and periods of employment, salary expected, etc. Box 129, AMERICAN MACHINIST.

OHIO

Wanted — General foreman by traveling crane manufacturer; must be fully experienced in all parts of the business; to such a man an excellent opening; state wages and full information; all replies treated as strictly confidential. Box 156, AMERICAN MACHINIST.

Wanted—First-class machinists, toolmakers die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood patternmakers, brass molders, polishers, buffers, finishers, spinners, millwrights, hammermen and blacksmiths who are seeking positions or desirous of improving on those which they have, to register their names and addresses with the free Employment Department of the National Metal Trades Association. Address Commissioner's Office, 605 New England Bldg., Cleveland, O.

PENNSYLVANIA

Machinist, first class of wide experience, required as inspector on machine tool work; state age, experience and salary expected. Box 77, AMERICAN MACHINIST.

Wanted—Instructors in mechanical engineering in an eastern institution; graduates from technical schools, preferably with one or two years' experience. Address with references, Box 115, AMERICAN MACHINIST.

Wanted—Master mechanic and superintendent for knitting machine shop, on new and repair work; steady habits, mechanical and executive ability essential; experienced knitting machine man preferred; permanent position and good salary to right man. Box 810, Reading, Penn.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

ALABAMA

Mechanical engineer and designer, 28, five years' experience in drafting room and shop, wants position offering a future; South preferred. Box 161, AMERICAN MACHINIST.

CALIFORNIA

In West, Middle or Southwest, position requiring a high grade man with brains, initiative, ability and experience; salary secondary consideration; engineering, mining or manufacturing. Box 159, AMERICAN MACHINIST.

ILLINOIS

Toolmaker, experienced on repairs to automatic screw machines, turret lathes, gear cutters and other first-class machinery, with knowledge of drafting and layout work, 20 years' experience, desires position. Box 135, AMERICAN MACHINIST.

MASSACHUSETTS

Superintendent; age 38; first class executive and highly successful manager of men; practical mechanic; now employed; highest references. Box 125, AMERICAN MACHINIST.

NEW JERSEY

Graduate mechanical engineer, two years' shop and seven years' designing experience, desires change. Box 151, AMER. MACHINIST.

NEW YORK

Chief draftsman, mechanical engineer, 37, 16 years steam, gas, hydraulic and automatic machinery, desires change. Box 140, AM. M.

Draftsman, special machine and tool designer, interchangeable parts; 10 years' experience; location immaterial. Box 141, AMERICAN MACHINIST.

Any firm wishing to make their own die molded castings can obtain the services of a man who is thoroughly posted by addressing Box 155, AMERICAN MACHINIST.

Foreman, middle aged, now employed, modern ideas, steam pumps, electrical and general machinery; A-1 hustler; can handle force with skill. Box 158, AMERICAN MACHINIST.

Superintendent, 35, desires change; light and medium work; strong on production, produces accurate work; references from present employer. Box 164, AMER. MACH.

Mechanical engineer, with extensive shop practice, thoroughly versed in designing and handling large machine shop, foundry and erection, desires position. Box 143, AM. MA.

Designer-draftsman, 29, 10 years' experience, including shop, engines, pumps, special and automatic machinery, now employed, wishes change of position; vicinity New York City. Box 163, AMERICAN MACHINIST.

General superintendent, hustling and aggressive; can crowd the work out, reduce costs and raise billing; expert at tools, dies, machinery, drafting, accurate estimator; experienced at contracting machine work and meeting price; past record will convince before closing. "Mechanical Engineer," AM. M.

Diemaker, A-1 mechanic, capable to design and build the most uptodate dies, expert on drawing dies, wishes position as foreman; 20 years' experience; five years foreman over die and press room; will go anywhere in the East or Middle West. Box 142, AM. MA.

An American, married, age 44, strictly sober, honest and industrious, over 25 years' successful experience as machinist, tool and model maker, mechanician, foreman, works manager and consulting engineer, broad, practical experience in manufacture of instruments of precision, tools and jigs for the rapid output of parts in manufacturing, over six years' varied experience with building, starting new factories and selling in the Orient, is open to consider positon; location no object; could travel; please be explicit in replying. Box 154, AMERICAN MACHINIST.

OHIO

Mechanical engineer, 12 years' experience, desires position as manager or superintendent of production. Box 145, AMER. MACHINIST.

PENNSYLVANIA

Cost accountant, 10 years in machine shops and foundries, desires to change; references. Box 162, AMERICAN MACHINIST.

Superintendent or factory manager, thoroughly familiar with the economical manufacture of interchangeable parts for medium and heavy machinery. Box 148, AM. MACH.

General foreman is open for a position as superintendent or general foreman; 32 years old, with good education; 12 years of experience as tool and diemaker on all kinds of tools and dies and manufacturing systems in the gun, adding machine and electrical line; guarantee to get results; correspondence to be mutually confidential. Box 120, AMERICAN MACHINIST.

TEXAS

Position as a mechanical draftsman, with a reliable company; have technical education, with shop experience. Address Box 591, Houston, Texas.

WISCONSIN

Foreman of drafting and tool room, die and jig designer; expert on designing and making dies for automobile stampings, executive ability; American; 38. Box 123, AM. M.

General superintendent or works manager is open for engagement; high class and aggressive; good organizer and systematizer; can produce maximum results from minimum expense; advertiser is 42 years old, has had 20 years of successful experience as a mechanic and manager of manufacturing establishments. Box 131, AMERICAN MACHINIST.

FOR SALE

For Sale—Acme automatic screw machines, practically new; over supply of one kind only reason for selling; condition guaranteed—One No. 51, ¼ inch; one No. 52, ⅜ inch; one No. 53, 1 inch; one No. 54, 1½ inches; write for prices. Box 93, AMERICAN MACHINIST.

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

Talks With Our Readers

By the Sales Manager

"The world do move."

Advertising was the subject of one of the six principal addresses given at the October meeting of the National Machine Tool Builders Association.

Ten or fifteen years ago such a thing would have been impossible.

Advertising then was surrounded with mystery, savored too much of the black art, and at its best was a gamble. Few knew anything about it, and they were looked upon with suspicion.

Since then a wonderful change has taken place.

Advertising is now a legitimate, productive, dividend-paying investment if it's systematically planned and properly followed out. Just as much so as any other department of modern business.

It is more honest, truthful, informative and interesting. A friend of both seller and buyer. It brings them together to their mutual interest and profit.

It pays the manufacturer to advertise his product just as much as it pays the consumer to read his ad and no more. The advertising rule must work both ways—it must pay the reader or it won't pay the advertiser. Advertising can't make poor goods succeed.

Advertising is today one of the greatest factors in modern American business. More than a billion dollars is spent on it each year in America alone.

We are glad to see such a progressive association as the National Machine Tool Builders Association discuss it.

The more the true northern light is thrown on it the better for all—the seller, the buyer and us.

The speaker at the National Machine Tool Builders' recent meeting was Thos. H. Moore, advertising manager of John Wanamaker, one of the world's greatest merchants and advertisers.

Here are some of the truths he spoke—truths that we have been advocating for years.

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Advertising is a business stimulant that must be well diluted with plain American horse sense. It is not a magician—or a quack medicine.

It is simply a salesman with a multiple tongue—who must work like any other salesman.

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Advertising will do two things for you: First, it will help you keep your present customers and increase your sales to those customers.

And, second, it will make new customers.

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But how to create new business. There is where the trade-paper man will come in with his argument. And there is merit in it too, for it would seem that the most economical way to build business in a particular industry would be to appeal to possible trade through the paper read from business necessity.

It is a pretty good rule never to buy space, in a paper of any kind, unless that paper is willing to give you most extensive details as to its circulation, as to quantity, quality, character—and where it goes.

And don't buy space in a paper just because you like that paper yourself. You are not selling goods to yourself—but to the other fellow.

* * * * *

You are men appealing along a certain direct line—to a limited class.

You are in shape to do your shooting with a rifle ball all the time.

* * * * *

One theory upon which men use large space is that they have something big to say and must say it in a big way—for the public largely takes you at your own estimate. The public, certainly, never rates you higher than you rate yourself.

* * * * *

Here are the sure tests of an advertisement:

Will it attract attention? And here you must look to your headlines, and pictures, your type space and position for answer.

Obviously it must be large enough to catch the eye.

Secondly, will it arouse enough interest to make the reader wade through it? It must bristle—so he won't drop it after the first sentence.

And thirdly, will it excite the readers' curiosity or create desire! Will it hit home—make a dent—make him feel he wants to know more about you and your goods?

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Remember, please, that the advertisement speaks for you. It is your mouthpiece.

It must fit you and your business methods.

It is a salesman of the house and must stand for the house.

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Only reliable products can be continuously advertised.